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AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
NAVAL AVIATION DEPOT
NORTH ISLAND
SAN DIEGO, CALIFORNIA 92135-5112

GASEOUS EMISSIONS FROM AIRCRAFT ENGINES

A HANDBOOK FOR THE CALCULATION OF EMISSION INDEXES AND GASEOUS EMISSIONS FROM AIRCRAFT ENGINES

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Naval
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GASEOUS EMISSIONS FROM AIRCRAFT ENGINES

STATEMENT "A" per Douglas Marable
Aircraft Environmental Support Office
Naval Aviation Depot, Naval Air Station
North Island, San Diego, CA 92135
TELECON 4/25/90

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PREFACE

The Commander, Naval Air Systems Command provides the Aircraft Environmental Support Office to the Naval Environmental Protection Support Service, through the Commanding Officer, Naval Aviation Depot North Island. The Aircraft Environmental Support Office is responsible for managing and issuing air emissions and noise level data from naval air operations and related maintenance functions.

The Naval Facilities Engineering Command, through the Naval Environmental Protection Support Service, assigned the Aircraft Environmental Support Office the task of preparing a Handbook of Gaseous Emissions from Aircraft Engines.

The first summary of gaseous emissions from aircraft engines, by the Aircraft Environmental Support Office, appeared in 1972. It was a two-page list of emissions from eight types of engines. This list soon expanded into the Aircraft Engine Emissions Catalog, which was a collection of emissions data obtained both by the Aircraft Environmental Support Office and by others. The Aircraft Engine Emissions Catalog, through the addition of emissions data by several revisions and supplements, soon became a document of some 400 pages. Now the user, who often had no experience in measuring or qualifications in evaluating emissions data, assumed the task of searching out fundamentals from a mass of data. Further expansion of the Aircraft Engine Emissions Catalog was destined to produce an unwieldy publication. It would not meet the need of most users for a convenient and reliable source of information about gaseous emissions from various types of aircraft engines.

The Aircraft Environmental Support Office decided that a Handbook, featuring our selection of typical emissions from an engine type, would be the best way to present emissions data. The Handbook would list only a single representative engine for each type/numeral/model indicator, unless changed emission characteristics, caused by the modification of the engine design, justified multiple listings.

While the Aircraft Environmental Support Office was collecting emissions data, SAE (formerly the Society of Automotive Engineers), through its E-31 Committee (Aircraft Exhaust Emission Measurement), was standardizing methods of emissions measurements and calculations. The work of the E-31 Committee produced a publication, Aerospace Information Report (AIR 1533), which defines optimum procedures for the calculation of basic emissions parameters for aircraft engines.

Gaseous Emissions From Aircraft Engines brings together the standardized calculations of SAE and the selections of emissions data of the Aircraft Environmental Support Office.

This Handbook is intended for operators of test facilities, officers at Naval Aviation Depots and Aircraft Intermediate Maintenance Depots, and other personnel who need to estimate the amount of gaseous emissions coming from the operation of aircraft engines. It shows how to calculate emission indexes from the measured concentrations of gases in the engine exhaust, and how to use emission indexes with engine operational data to estimate the total emissions from an engine. It defines how the Aircraft Environmental Support Office calculates and uses emission indexes to estimate emissions from aircraft engines. It supports these explanations with examples of the calculations. It also shows how to use computers and small calculators to make the calculations. The Handbook includes examples of emissions data for those engines most likely to be operated at naval air installations.

Of course, this Handbook must change to keep up-to-date. We expect to obtain improved emissions data as well as emissions data for other engines. We expect revisions to the SAE standard methods for calculating emission indexes, and when these occur we will modify AESO 1-87 as needed. We expect to write enhanced and additional computer and calculator programs. We may change format of tables and data sheets for improved ease of use. With these changes in mind, the format is loose-leaf. In this way we can expand sections and appendixes through the issue of additional pages rather than by issue of a new report. Each data sheet and each summary table has the date of printing at the bottom of the page.

This copy of AESO Report No. 1-87 contains all additions and revisions to April 4, 1990.

We look forward to receiving comments from users and readers of this Handbook.

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GASEOUS EMISSIONS FROM AIRCRAFT ENGINES

A Handbook for the Calculation of Emission Indexes
and Gaseous Emissions from Aircraft Engines

AESO Report No. 1-87, September 1987

EXECUTIVE SUMMARY

For test cells, regional and state air pollution control agencies require that naval air installations obtain first, a permit to construct, and then a permit to operate. To apply for permits, personnel responsible for operating the test cells need to know the amounts of gaseous and particulate emissions formed during engine testing. This Handbook shows how to estimate the gaseous emissions of carbon monoxide, oxides of nitrogen and hydrocarbons formed during the operation of gas turbine engines.

The estimation of total emissions needs, for each power setting of the engine, (1) a ratio of the contaminant formed to the amount of fuel used (the so-called emission index), (2) the duration of the operation and (3) the fuel flow rate. Of these, the emission index is the most difficult to find.

This Handbook furnishes summary tables of representative emission indexes, at various power settings, for the gas turbine engines most likely to be operated at naval air installations. These tables also include fuel flow rates. Thus, anyone knowing the duration of the power settings can estimate the total gaseous emissions from various aircraft engines. The discussion of the emission index includes instructions on how to calculate it using both computers and small programmable calculators.

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GASEOUS EMISSIONS FROM AIRCRAFT ENGINES

1 INTRODUCTION

Gaseous emissions from aircraft engines are an obvious source of air contamination. Although military aircraft engines are exempt from emission regulations, the facilities for testing them, such as test cells, are not. Test cells are emission sources because of the aircraft engines operating within them. Personnel, responsible for operating these facilities, often must apply to regional regulating agencies for authority-to-construct or permission-to-operate. For gaseous emissions, the regulating agencies want to know the concentrations and the amounts of the combustion products such as carbon monoxide, carbon dioxide, oxides of nitrogen, hydrocarbons and oxides of sulfur coming from the operation of the engine. They need this information to determine whether or not a facility is in compliance with their regulations. If a facility is out of compliance, emissions data aids in finding an acceptable solution, such as modification of the facility, an emissions trade, or a rule change. One use of this Handbook is to estimate emissions from the testing of an aircraft engine in a test cell and, hopefully, to eliminate the expense and delay of additional and meaningless source testing. We believe that this Handbook contains sufficient data to make a reasonable estimate of the gaseous emissions coming from most of the gas turbine engines in the navy inventory.

The estimation of the amount of a gaseous constituent in the exhaust from an aircraft engine, for a specified length of time at any power setting, uses (1) a ratio of the gaseous constituent formed to the amount of fuel used (the so-called emission index), (2) the duration of the operation and (3) the fuel flow rate. With these data, the estimation of total emissions is simply a matter of finding the amount of a constituent formed at each power setting, then adding the amounts from the various power settings to get the total emissions of that constituent. However, of the needed data, only the fuel flow rates are readily available. Emission indexes are hard to find and durations of operation are poorly defined.

Emission indexes are the results of special testing and, even if known, normally are not a part of engine operational records. Also, an emission index is not a constant value. Emission indexes for the same power setting vary not only among engines of the same type and model but also among the same power setting used at different times during an operating sequence for the same engine.

Do not expect to find accurate records of engine run times at various power settings at the facility testing the engine. Although these records often specify a run time to qualify the engine at various power settings, they do not account for other run times such as those needed to get the engine to stable conditions, those used in changing between power settings and those used in special test sequences.

This Handbook first selects, from the database at the Aircraft Environmental Support Office, those emission indexes, which in our opinion, represent the emissions from an engine type, and are suitable for estimating the amounts of emissions from similar engines. Then, the summary tables of section 7 list emission indexes and other emissions data for a group of power settings. These tables include fuel flow rates. Now, by referring to a single page, anyone knowing the engine run times at various power settings can estimate the total gaseous emissions from various aircraft engines. We expect that many users of this handbook need only the summary tables of section 7.

Because of the importance of the emission index and because some users may have to calculate it, this Handbook describes in detail its calculation and use.

The optimum calculation of the emission index uses a computer for the matrix solution of ten combustion equations. The Aircraft Environmental Support Office believes that the IBM AT/XT (or compatible) computers, now widely used, will have increasing availability. Our computer programs are for it. This Handbook gives all the details needed to get data into the matrix and solve it using such computers. The computer programs (Appendix B), feature steps to make a permanent record of both the data used in the calculations and the results of the calculations.

For those without a computer, this Handbook shows how to use a small programmable calculator to get solutions equivalent to the ones obtained using a computer. The calculator programs need a Hewlett Packard HP-41C/41CV/41/CX calculator. The calculator programs (Appendix A) record entries and calculations, but the most important programs also have a non-printing version.

Appendix C contains a collection of the data sheets each of which gives complete information about a single power setting, including all of the data needed to calculate the emission index by the matrix solution. These data sheets provide the data for the summary tables of section 7. We expect that, because of its specialized character, most users of this Handbook do not need Appendix C. Accordingly, this Handbook may be transmitted without it.

2 BACKGROUND INFORMATION

The estimation of the gaseous emissions coming from an aircraft engine needs an emission index for each constituent of the exhaust. This section defines the emission index, gives background information about its calculation, and relates the contents of this Handbook to Aerospace Information Report AIR 1533* (Reference 1).

2.1 Emission Index

The term 'emission index' is the same as the term 'emission factor' as defined by the U. S. Environmental Protection Agency in AP-42 (Reference 2):

> "One of the most useful (and logical) tools for estimating typical emissions is the 'emission factor', which is an estimate of the rate at which a pollutant is released to the atmosphere as a result of some activity, such as combustion or industrial production, divided by the level of that activity (also expressed in terms of a temporal rate). In other words, the emission factor relates the quantity of pollutants emitted to some indicator (activity level) such as production capacity, quantity of fuel burned, or vehicle miles traveled."

When applied to aircraft engines, an emission index (emission factor) is a ratio which relates the amount of a pollutant, in the exhaust from an aircraft engine, to the amount of fuel used. Because aircraft engines use relatively large amounts of fuel, a convenient expression for the emission index is units of mass per hour divided by 1000 units of mass per hour, i.e., pounds of pollutant per 1000 pounds of fuel, or any other mass units, such as kilograms of pollutant per 1000 kilograms of fuel. The emission index is independent of the total amount of fuel used.

2.2 Methods of Calculation for the Emission Index

At first, the calculation of an emission index used a linear equation (References 3, 4 and 5). The variables in this equation are the measured concentration of the constituent in the exhaust, the molecular weight of the constituent and the hydrogen-to-carbon ratio of the fuel. Later, References 5, 6 and 7 developed, for aircraft piston and gas turbine engines, a procedure which used a group of simultaneous equations in a matrix solution. Reference 8 developed a more comprehensive matrix solution from the basic matrix.

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* This Handbook refers to Reference 1 as SAE AIR 1533. Some references to SAE AIR 1533 include a following number in parenthesis. This number identifies an equation in SAE AIR 1533.

The matrix method sets up, through a single solution, parameters for determining all of the emission indexes, as well as other variables. The matrix method needs a computer of sufficient size and speed to make the calculations for the solution of a 10 x 10 or an 11 x 11 matrix. The size 11 matrix uses argon and nitrogen as separate constituents. The size 10 matrix combines them. Linear equations, derived from the matrix solution, allow a small programmable calculator to determine emission indexes which are equivalent to those obtained using the matrix solution.

2.3 Aerospace Information Report AIR 1533 (SAE AIR 1533)

The SAE* Technical Board acknowledges Reference 8 as the source for much of the subject matter in their publication, SAE AIR 1533. The SAE Technical Board recommends this publication as an American National Standard for the calculation of emission indexes for gas turbine engines. The Aircraft Environmental Support Office (AESO) supports this procedure as the optimum method for the calculation of emission indexes and expects to use it as the primary method for determining all emission indexes.

This Handbook is correlated with SAE AIR 1533. It uses the same equations, terms, definitions, nomenclature and symbols, except as noted for hydrocarbons and efficiency (see par. 2.4). The user of this Handbook needs to refer to SAE AIR 1533 for information such as the chemical equation for the combustion of a hydrocarbon fuel in air, the set of ten simultaneous equations needed for the matrix and the development and use of the comprehensive matrix solution. This Handbook does not repeat this information but instead, supplements SAE AIR 1533 by concentrating on applications, further explanations, examples of specific calculations, and comparisons of the calculations by linear equations with those by the matrix solution. To enhance coordination, this Handbook often uses the data from the sample calculation of SAE AIR 1533 (pages 34-36) in its examples.

For the convenience of the user, the Aircraft Environmental Support Office has purchased reprints of SAE AIR 1533 and expects to include one with each copy of this Handbook as long as our supply lasts. We advise the user that SAE AIR 1533 is not a part of this Handbook and that the copyright of SAE AIR 1533 belongs to SAE.

NOTE: THIS COPY OF AESO REPORT NO. 1-87 DOES NOT INCLUDE A REPRINT OF SAE AIR 1533.

* The Society of Automotive Engineers now uses the acronym SAE as the name of the organization.

2.4 Nomenclature and Suggested Values

In this Handbook, the notations of nomenclature and suggested values appear close to the place of use rather than in a summary. These are the same in both this Handbook and SAE AIR 1533 except as noted in paragraphs 2.4.1 and 2.4.2. Both publications use the same definition of terms. Those needing complete lists should refer to pages 3 to 5 of SAE AIR 1533.

2.4.1 'Hydrocarbons'

This Handbook uses C_xH_y to indicate the exhaust hydrocarbons rather than the abbreviation HC. A hydrocarbon fuel uses the general formula C_mH_n. The use of C_xH_y or C_mH_n is consistent with using chemical formulas as nomenclature for carbon monoxide, carbon dioxide and oxides of nitrogen. Since the composition of the exhaust hydrocarbons usually is not known, this report uses x = m and y = n.

2.4.2 'Efficiency'

To accommodate different computer printers, this Handbook sometimes uses 'NO_x C/E', instead of the Greek letter eta (η), as a notation of the efficiency for the conversion of the oxides of nitrogen to nitric oxide. It also writes out the term 'combustion efficiency' instead of using the notation $_b$. The letter eta appears at different locations in the character set of the printers and sometimes is missing.*

* The print-outs from the computer programs in this Handbook also use the degree symbol. It too appears at different locations in the character sets of printers. Users may have to modify our computer program to coordinate with their printer. Because we used BASIC as the program language, modification is easy. For example, in the program line <u>LPRINT CHR$(###),"F";</u>, the value field (###) locates the degree sign in the character set. For the IBM Proprinter the value field is 248, for the HP LaserJet Printer, the value field is 179. Change this line as needed.

3 MEASUREMENTS NEEDED TO DETERMINE EMISSION INDEXES

The concentrations of carbon monoxide, carbon dioxide, oxides of nitrogen, and hydrocarbons in the engine exhaust are the most important variables in the calculation of emission indexes and, as a group, account for most of the value of the indexes. These concentrations must be measured, at each power setting, during the operation of the engine. Ideally, other measured data include the humidity of the ambient air (wet and dry bulb temperatures, relative humidity and barometric pressure), the concentrations of nitric oxide (NO), the efficiency of the converter for changing nitrogen dioxide (NO_2) to nitric oxide, the concentration of oxygen, and the carbon-hydrogen analysis of the fuel. Paragraphs 3.4, 3.5, 3.6 and 3.7 tell how to estimate these data when they are missing. This section also discusses adjustments to the measured concentrations to compensate for instrument interferences by oxygen, carbon dioxide and water.

3.1 Units of Measurement

Emissions data usually record the measured concentrations of carbon dioxide and oxygen as percents, and the concentrations of carbon monoxide, oxides of nitrogen, nitric oxide, and hydrocarbons as parts per million (ppm). The combustion equations discussed in SAE AIR 1533 and in this Handbook use mole fraction concentrations (indicated by number enclosed in brackets, [ ]). To convert percent to a mole fraction concentration, divide by 100. To convert parts per million to a mole fraction concentration, divide by 1,000,000. The computer and calculator programs in this Handbook accept the inputs of the concentrations of carbon dioxide and oxygen as percents and the inputs of all other concentrations as parts per million. The programs make the needed conversions to mole fraction concentrations.

3.2 Sampling Position

If the engine is on a test stand or in an airframe, the sampling position is at the engine exhaust plane. If the engine is in a test cell, the sampling may be elsewhere in the exhaust system. Most of the sampling posicions used by the Aircraft Environmental Support Office were in a test cell after the addition of supplemental air, so that the measured emissions represented the exhaust from the test cell rather than the exhaust from the engine. For a completed combustion reaction, the concentrations of the constituents may vary with the sampling position; the emission index, which is a ratio, does not. For example, the concentration of the constituents in a sample taken directly behind an engine will be much higher than the concentrations of one withdrawn further from the engine, after the addition of air to the exhaust stream. By contrast, the emission indexes at each of these positions will be about the same. The air did nothing other than dilute the concentration.

3.3 Basis of Measurement

The basis of measurement of the concentrations of gases in the exhaust of an engine is wet, semi-dry or dry. The exhaust stream from the

engine contains water formed during combustion as well as that from the ambient air. If a gas stream is not dried before analysis, the basis of measurement is wet. If the gas stream is dried partially, for example, by passing through a cooling coil to remove most of the water, the basis of measurement is semi-dry. If the gas stream is dried completely the basis of measurement is dry.

A common measurement basis is semi-dry for carbon monoxide, carbon dioxide, and oxygen, and wet for oxides of nitrogen and hydrocarbons. Some measurements of the oxides of nitrogen may be on a semi-dry basis. The recommended basis for hydrocarbon measurements is wet (References 3, 4 and 7). However, some instruments measure hydrocarbons on a semi-dry basis. The computer and calculator programs in this Handbook do not adjust for semi-dry hydrocarbon measurements. To use such measurements, adjust to a wet basis before using in the programs.

3.4 Humidity of the Inlet Air and the Exhaust Sample

Conversions from a semi-dry to a wet (or dry) basis and the calculation of X/m use the variable h, which is the humidity of the inlet air (moles of water vapor per mole of dry inlet air). All emission calculations need a value for h, either determined or calculated. Figure 3-1 shows how to obtain the humidity of the inlet air using either a psychrometric chart or a vapor pressure-temperature table.

When humidity data are missing, use a reasonable estimate for h based on representative relative humidities, temperatures and barometric pressures. For example, The Aircraft Environmental Support Office uses $h = 0.01$ for measurements in California, and $h = 0.02$ for measurements in Florida.

3.4.1 Humidity of the Inlet Air from Psychrometric Charts

Psychrometric charts appear in many engineering handbooks. Usually these charts are relatively small, appear cluttered because of much information in a small space, and consequently are hard to read. Those using psychrometric charts should find a large one such as Reference 9. A typical chart plots dry bulb (ambient) temperature as the abscissa and specific humidity (pounds or grains of water per pound of air) as the ordinate. In addition, curves show various relative humidities and dew points. Lines show wet bulb temperatures.

To determine the specific humidity from relative humidity measurements, find the intersection of any two of the following: the dry bulb temperature line, the wet bulb temperature line or the relative humidity curve; then read across to the specific humidity on the ordinate. Or, if the dew point is given, read directly across to the specific humidity. Convert the specific humidity ($\underline{W}$) (a weight ratio) to the humidity of the inlet air (h) (a molar ratio) by using the ratio of the molecular weights of water (M_{WATER}) and air (M_{AIR}) (see SAE AIR 1533 page 34). A psychrometric chart applies to only one barometric pressure, usually 29.92 in. Hg.

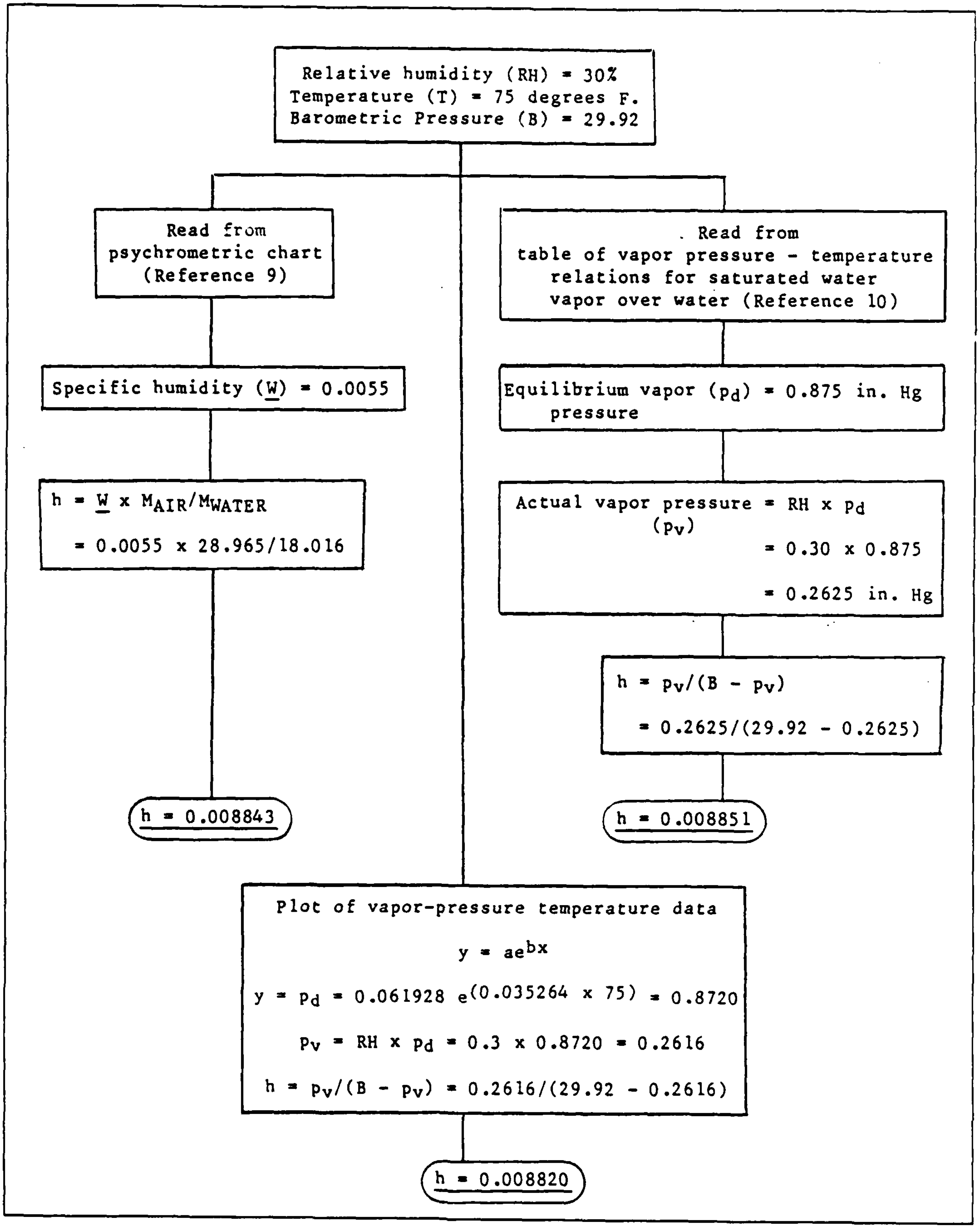

Figure 3-1. Calculation of the humidity of inlet air (h) as moles of water vapor per mole of dry inlet air.

3.4.2 Humidity of Inlet Air from Vapor Pressure-Temperature Tables

Likewise, many engineering handbooks contain tables of vapor pressure-temperature relations for saturated water vapor over water. Use these tables to read directly the equilibrium vapor pressure for any temperature. Multiplication of the equilibrium vapor pressure by the relative humidity ratio gives the actual vapor pressure (or vapor pressure at the dew point). The humidity of the inlet air (h) is the ratio of the actual vapor pressure to the air pressure, $h = p_v/(B - p_v)$.

For use in computer and calculator programs, the vapor pressure-temperature data needs to be expressed as an algebraic equation. Analysis of vapor pressure-temperature data from reference 10 using program CFIT from a Hewlett-Packard Advantage Advanced Solutions Pac showed that they fit the exponential equation

$$y = ae^{bx}$$

where y = vapor pressure (in. Hg), x = temperature (degrees F.), a = 0.053226 and b = 0.038251 (for temperatures below 50 degrees); a = 0.061928 and b = 0.035264 (for temperatures from 50 to 75 degrees); and a = 0.080455 and b = 0.031767 (for temperatures above 75 degrees).

The user of AESO computer and calculator programs enters either the humidity of the inlet air (h) or those data needed for its calculation. These data are (a) a combination of the relative humidity, dry bulb (ambient) temperature and barometric pressure, or (b) the dew point temperature (at which, by definition, relative humidity = 100%) and the barometric pressure. Figure 3-1. compares the values of h calculated by each of these methods with the value obtained from a psychrometric chart.

3.4.3 Humidity of the Exhaust Sample

The term 'h_{sd}' is the humidity of the exhaust sample after leaving the gas dryer. The water content is reduced to about 1%. This Handbook uses a constant value of 0.00607 for h_{sd}. See SAE AIR 1533, page 34.

3.5 Nitric Oxide and Converter Efficiency

The oxides of nitrogen, in the exhaust from a gas turbine engine, are mostly in the form of nitric oxide with small amounts of other oxides of nitrogen, of which the principal one is nitrogen dioxide. Nitric oxide is the only oxide of nitrogen detected by the method of analysis (chemiluminescence). To determine the total concentration of the oxides of nitrogen, the nitrogen dioxide first must be converted to nitric oxide by heat or by ultraviolet irradiation. This conversion is not complete. The measured concentration of nitrogen dioxide (the concentration of the oxides of nitrogen minus the concentration of nitric oxide) must be divided by the efficiency of the converter to get the true concentration of nitrogen dioxide. This concentration of nitrogen dioxide, when added to the concentration of nitric oxide, gives the concentration of the oxides of nitrogen.

For those tests recording only the concentration of the combined oxides of nitrogen, this Handbook assumes that the oxides of nitrogen are 97% nitric oxide and 3% nitrogen dioxide. This is a realistic composition for high engine power settings, which are the ones producing most of the oxides of nitrogen and thus most affecting the emission index. If the efficiency of the converter is unknown, 95% is a reasonable estimate.

3.6 Oxygen

The concentration of oxygen can be measured, but its calculation either by using equation (78) of SAE AIR 1533, page 25, or by a matrix solution, is more convenient. In our measurements we found that the sensor of the oxygen analyzer needed frequent servicing or replacement.

3.7 Fuel Analysis

Fuel analysis determines the variables m and n (the molecular constants for the fuel C_mH_n). If m and n have not been determined by fuel analysis, this Handbook uses a hydrogen (n) to carbon (m) ratio of 2 for JP-4 fuel (n = 19.0 and m = 9.5) and 1.8 for JP-5, (n = 23.4, and m = 13.0)

3.8 Adjustments to Measured Concentrations

3.8.1 Adjustment for Carbon Dioxide in Ambient Air

Ambient air contains carbon dioxide and this concentration must be subtracted from the measured concentration of carbon dioxide in the exhaust, before calculating emission indexes. Some combustion equations and all matrix solutions include this correction. The calculations of all emission indexes use the concentration of carbon dioxide. So, failure to correct for ambient carbon dioxide affects all of the emission indexes.

3.8.2 Adjustments to Measured Concentrations for Instrument Interferences

All methods for the calculation of emission indexes need adjustments to the measured concentrations of the constituents for (1) the interference of oxygen on the measured concentration of carbon dioxide, the interference of carbon dioxide, and water on the measured concentration of carbon monoxide, and (3) the interference of carbon monoxide and water on the measured concentration of the oxides of nitrogen. When using linear equations, the measured concentrations must be adjusted before calculating the emission indexes. The matrix method allows the use of the measured concentrations with the instrument coefficients J, L, L', M and M' making the adjustments during the solution. The coefficient J adjusts the measured concentration of carbon dioxide for the interference of oxygen. The coefficients L and M adjust the measured concentration of carbon monoxide for the interferences of carbon dioxide and water. The coefficients L' and M' adjust the measured concentration of the oxides of nitrogen for interferences of carbon dioxide and water.

SAE AIR 1533 describes how to use the instrument coefficients J, L, L', M, and M' to make adjustments but does not tell how to determine these coefficients other than by remarks such as "to be determined by experiment" or "from the vendor." SAE AIR 1533 (page 10) gives typical values for the interference coefficients L, L', M, and M'. These are the same as the ones determined for a specific instrument at the National Gas Turbine Establishment (Reference 8). SAE AIR 1533 (page 34) uses +0.09 as the value of J. Reference 8 states that -0.07 is the median value for J from a survey of users in the United Kingdom and in the United States. SAE AIR 1533 does not reference the source of the +0.09 value.

The following paragraphs describe how the Aircraft Environmental Support Office determines the instrument interference coefficients. We expect to modify these methods, as needed, to conform to anticipated standardization of methods.

3.8.3 Interferences to the Carbon Dioxide Measurement

The concentration of carbon dioxide needs adjustment for the interference of oxygen. The Aircraft Environmental Support Office has not determined the value of J for its carbon dioxide analyzer and will use J = -0.07 as an approximate value in calculations of emission indexes from our measurements. Elsewhere in this Handbook, however, examples of calculations use J = +0.09 to permit direct comparisons with the sample calculation of SAE AIR 1533, pages 34 - 36.

3.8.4 Interferences to the Carbon Monoxide Measurement

The mobile emissions laboratory of the Aircraft Environmental Support Office uses nondispersive infrared analyzers to determine the concentrations of carbon monoxide and carbon dioxide. The same gas stream passes through both instruments. Concentrations of carbon dioxide and water change the output from the carbon monoxide analyzer even though there is no carbon monoxide in the gas stream. These outputs appear as positive deflections of the recorder trace, from the zero calibration of carbon monoxide, and must be subtracted from the measured values of carbon monoxide.

The amount of the deflection also depends upon the characteristics of the optical system of the infrared analyzer. Some analyzers use filters to eliminate most of the interferences from carbon monoxide and water. With proper filters, the adjustments to the measured concentrations for the presence of carbon dioxide and water are small, causing less change in the emission indexes than the change expected from variations in instrument performance.

3.8.5 Determination of L

To determine L, we passed samples containing various known amounts of carbon dioxide in nitrogen through the carbon monoxide analyzer. Each sample caused a positive response from the analyzer which was equated to a concentration of carbon monoxide in parts per million.

The carbon monoxide analyzer, used in the first measurements by the Aircraft Environmental Support Office, did not have filters to decrease the interferences from carbon dioxide and water. A calibration gas containing 1% of carbon dioxide caused the same response in the carbon monoxide analyzer as a carbon monoxide concentration of 9 ppm. For a calibration gas containing 3.04% carbon dioxide, this response was equal to 18 ppm of carbon monoxide or 6 ppm for each 1% of carbon dioxide. This instrument soon was modified with filters. Filters reduced the response to that equal to about 1 ppm of carbon monoxide for each 1% of carbon dioxide.

In equation (13) of SAE AIR 1533, the term $L[CO_2]$, when the concentration of carbon dioxide is 1%, must have a value which decreases the measured concentration of carbon monoxide by 9 ppm. Thus, $L[CO_2] = -0.000009$. Thus, $L \times 0.01 = -0.000009$, or $L = -.0009$. Using a similar calculation, the value of L at 3% carbon dioxide is −0.0006, i.e., ($L \times 0.03 = -0.000018$). For adjustments without filters, the Aircraft Environmental Support Office uses $L = -0.0009$ for carbon dioxide concentration to 1.2%, $L = -0.0008$ for concentrations from 1.2 to 1.8%, $L = -0.0007$ for concentrations from 1.8 to 2.5% and, $L = -0.0006$ for concentrations above 2.5%. For measurements made with filters, $L \times .01 = -0.000001$ and $L = -0.0001$.

3.8.6 Determination of M

To determine M, we passed ambient air through a cooling bath (water-ethylene glycol regulated at zero degrees F by refrigeration) to condition the air to a semi-dry basis. We assume that now $[H_2O] = h = 0.00607$. Using our infrared analyzer without filters, the instrument response varied. The deflection was the same as that caused by 13 ppm to 40 ppm of carbon monoxide. Filters reduce this response to a deflection which was the same as that caused by about 2 ppm of carbon monoxide. Because of variation in the response of the infrared analyzer to ambient air, each test made using the infrared analyzer without filters uses its own value for M.

Just as previously described for L, the calculation of M uses the term $M[H_2O]$ from equation (13) of SAE AIR 1533. For example $M[H_2O] = -0.000013$. Then, if $[H_2O]$ is 0.00607, $M = -0.000013/0.00607 = -0.00214$ or, −0.00659 for the interference equivalent to 40 ppm. With filters, $M = -0.000002/0.00607 = -0.00033$.

3.8.7 Interferences to the Oxides of Nitrogen Measurement

The Aircraft Environmental Support Office has not determined values for L' and M' for any of the three different NO_x analyzers used in our measurements. We will use $L' = 0.14$ and $M' = 0.28$ as approximate values.

4 CALCULATION OF EMISSION INDEXES

The efficient calculation of emission indexes, using linear equations, needs a programmable calculator. The calculation, using the matrix method, needs a computer. This section shows how to use both calculators and computers to determine emission indexes. The calculator and computer programs feature print-outs which record the variables used and the parameters calculated. With adjustment to the measured concentrations of the constituents for humidity, instrument interferences and converter efficiency, the calculator program gives the same emission indexes as the computer program. The adjustments to the measured concentrations, although correct technically, cause only slight changes in the emission indexes.

4.1 Molecular Weights

The calculation of an emission index needs a molecular weight for the constituent of the emission index. For carbon monoxide and carbon dioxide there is but one constituent, and the molecular weight is the same as the formula weight.

For the oxides of nitrogen the composition is mostly nitric oxide with small amounts of nitrogen dioxide. By convention, the emission index for the oxides of nitrogen is calculated as if there were a single oxide, namely nitrogen dioxide.

For hydrocarbons, there are many constituents. The formulas and molecular weights used for the calculation of this index are CH, 13.019 (Reference 4); $CH_{y/x}$, usually 13.825 or 14.027 (References 1, 5 and 7); and CH_4 (methane), 16.043 (References 3 and 8). This Handbook uses the notation $CH_{y/x}$ to indicate $[M_C + (y/x)(M_H)]$. Assuming hydrogen to carbon ratios (y/x) of 2.0 for JP-4 fuel and 1.8 for JP-5, the molecular weight of hydrocarbons is 14.027 (equivalent to CH_2) for JP-4 and 13.825 (equivalent to $CH_{1.8}$) for JP-5.

In calculations from AESO data, the tables of this Handbook give emission indexes for hydrocarbons as if the constituent was either $CH_{y/x}$ or CH_4. When recording data from other sources, this Handbook uses the hydrocarbon emission index as reported. To convert between hydrocarbon emission indexes, multiply by the appropriate ratio of molecular weights. For example, to convert EI(CH_4)to EI(CH_2), multiply by 14.027/16.043. To convert EI(CH_4) to EI(CH), multiply by 13.019/16.043.

4.2 Calculation of Emission Indexes Using Linear Equations

The simplest method for the calculation of an emission index uses a linear equation such as equations (1) or (2) of Figure 4-1. (References 3, 4, and 5). Note that Reference 3 gives an equation for the calculation of the "CO emission rate." This equation includes the terms of equation (1) which calculate an emission index. Reference 3 does not identify these terms as an emission index. Equations (1) and (2) differ from one

$$EI_z = \left(\frac{[z]}{[CO] + [CO_2] + [C_xH_y]}\right)\left(\frac{10^3\, M_z}{M_C + \alpha M_H}\right) \qquad (1)$$

$$EI_z = \left(\frac{[z]}{[CO] + [CO_2] + [C_xH_y] - T}\right)\left(\frac{10^3\, M_z}{M_C + \alpha M_H}\right) \qquad (2)$$

$$EI_z = \left(\frac{[z]}{[CO] + [CO_2] + [C_xH_y]}\right)\left(\frac{10^3\, M_z}{M_C + \alpha M_H}\right)(1 + TX/m) \qquad (3)$$

[z] is the mole fraction concentration of a constituent z of the exhaust, specifically the mole fraction concentration of carbon monoxide, carbon dioxide, oxides of nitrogen (as nitrogen dioxide) or hydrocarbons (as $CH_{y/x}$ or as methane). Note that z is not the same as the variable Z which is defined by equation SAE AIR 1533 (59), page 22.

M_z is the molecular weight of the constituent, specifically: carbon monoxide (28.0104); carbon dioxide (44.0098); nitrogen dioxide (46.0055); CHy/x (14.027, when y/x = 2); or methane (16.043).

M_C is the atomic weight of carbon (12.011).

M_H is the atomic weight of hydrogen (1.008).

α is the hydrogen-carbon ratio of the fuel, which is about 2 for JP-4 and about 1.8 for JP-5.

T is the mole fraction of carbon dioxide in the dry inlet air (0.00032).

X is the number of moles of dry air per mole of fuel in the initial air fuel mixture. For the determination of X/m use equations 60 and 61 of SAE AIR 1533, page 22.

m is the molecular constant for carbon in the fuel C_mH_n.

Figure 4-1. Combustion equations for the calculation of emission indexes.

another only in that equation (2) subtracts the concentration of carbon dioxide in ambient air (T) from the measured concentration of carbon dioxide. These equations can be solved with a simple calculator, or even without one. References 1 and 8 derived equation (3) from products of the matrix solution of simultaneous combustion equations. Equation (3) is more complicated to solve than equations (1) or (2) because it needs the calculation of X/m. Its solution with a simple calculator is tedious, but becomes easy with a programmable calculator. The emission indexes calculated by equations (2) and (3) are the same when the user adjusts the concentration of the constituent for the effects of humidity, instrument interferences and converter efficiency

4.3 Calculation of Emission Indexes by the Matrix Solution of Combustion Equations

The optimum method (Reference 1) for the calculation of emission indexes uses a comprehensive matrix solution of ten simultaneous equations describing the chemical combustion of a hydrocarbon fuel. This method should be used whenever feasible. As already mentioned, the user of this Handbook must refer to SAE AIR 1533 for the derivation of the matrix from the combustion equations and the modification of the basic matrix to the comprehensive matrix.

The matrix method has the advantage over the use of linear equations in that it develops, in a single solution, values of P, (P_1-P_8), P_T and X. This list is the P vector. The values in the P vector allow the calculation of all of the emission indexes of the constituents as well as the wet and dry concentrations of the constituents of the exhaust and other parameters needed in combustion studies. The matrix method needs a computer for its solution. Although solution of a size 10 matrix using a small calculator is possible, it is not practical because of the time needed for the inversion of the matrix. The computer program for the matrix solution needs, as input, the measured concentrations of the con-ituents, the humidity terms needed to adjust them, and the instrument interference coefficients.

4.4 Aids for the Solution of Linear Equations and the Matrix

4.4.1 Solution of Linear Equations Using a Programmable Calculator

Appendix A, which contains selected pages from Reference 12, gives instructions and programs for the use of a small programmable calculator to solve equations (2) and (3) of Paragraph 4.2. Figures A1-1 to A1-5 give examples of the calculations needed to adjust the measured concentration of the constituents, and to determine the emission indexes, the fuel to air ratio and the combustion efficiency. These examples use the data of the sample calculation of SAE AIR 1533. Programs AIRAP and AIRA use equation (3). Program AIRB uses equation (2). Program AIRAP makes a permanent record of the data entered and calculated. Program AIRA uses the same data as program AIRAP but shows the calculations only in the display of the calculator. Program AIRB is satisfactory for quick estimates especially when nothing is known about the quality of the data or the adjustments to the measured concentrations. With adjustments for

instrument interferences and humidity, however, program AIRB, gives values which are very close to, or sometimes the same as, those obtained by equation (3). Like Program AIRA, program AIRB shows the calculations only in the display of the calculator.

4.4.2 Solution of the Matrix Using a Computer

Appendix B lists two computer programs MATEI (MATrix Emission Index and SAMPFL (SAMPle FiLe). Both programs are in BASIC language for an IBM PC AT or XT computer (or IBM PC compatible computers).

The program MATEI uses the matrix solution of Table C-1 of SAE AIR 1533, page 38, written in BASIC instead of FORTRAN. If a computer has a library of matrix functions, BASIC commands such as MAT I = INV(A): MATI1 = I*A: MAT P = I*F can replace lines 120 - 410 of Table C-1. Program MATEI adds, to the program in table C-1, the many steps needed to get the data to the matrix and print the calculations from it. The user of program MATEI has the option of entering data from a preassembled file or adding it to the program in response to inquiries on the monitor. Program MATEI uses either an IBM Proprinter or a Hewlett-Packard LaserJet printer. An option of Program MATEI, uses a LaserJet printer with a T font to add lines to the print-out. For the preparation of the data sheets in this Handbook, the Aircraft Environmental Support Office used an enhanced version of program MATEI, namely MATEIE. This program uses two additional fonts, Prestige Elite and Math 8, to change the style of the print-out. The calculations from both programs are the same.

Program SAMPFL explains how to prepare a data file for use with program MATEI. Each file has a unique name. Each file represents a specific power setting for a specific engine.

Appendix B includes: (a) Figure B1 which lists the 100 elements of the comprehensive matrix using the data of the sample calculation of SAE AIR 1533, (b) Figure B2 which shows the matrix constant, the P vector; and (c) Figure B3 which gives specific examples of calculations using the P vector. The values in the P vector (Figure B2) are the same as those of the P vector reported by SAE AIR 1533. These figures are references for anyone installing the matrix solution on a computer system.

4.5 Print-outs from Computer and Calculator Programs

4.5.1 Print-outs from the Computer Program MATEIE

Figures 4-2 and 4-3 show the print-outs from Program MATEIE. The purpose of the print-out is to make a data sheet which shows the original data used in the matrix, records calculations from the P vector of the matrix and gives information about the engine test. Each data sheet describes gaseous emissions at a single power setting for a specific engine. Lines group the data sheet into blocks, which are identified by letters. For comparison with SAE AIR 1533, Figure 4-2 shows the data sheet prepared by Program MATEIE using the data of the sample calculation of SAE AIR 1533. Figure 4-3 shows the data sheet for an engine run which includes engine operation data and the measurement of oxygen.

A	SAE	SAMPLE CALCULATION	File SAE

B

$J = 0.09$		$m = 9.5$
$L = -0.0001$		$n = 19.0$
$L' = 0.14$		$\eta = 0.95$
$M = -0.00045$	$h = 0.008843$	
$M' = 0.28$	$h_{sd} = 0.00607$	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	500	sd	497.6	494.6	483.4	47.65
Carbon dioxide	%	2.00	sd	2.045	2.032	1.986	3076.41
Oxides of nitrogen	ppm	20	w	21.42	21.29	20.80	3.37
Nitric oxide	ppm	9	w	9.37	9.31	9.10	1.47
Nitrogen dioxide	ppm			12.05	11.98	11.70	1.90
Hydrocarbons, $CH_{y/x}$	ppmC	225	w	231.7	230.3	225.0	11.11
Hydrocarbons, CH_4							12.71
Oxygen	%			18.088	17.979	17.569	
Nitrogen	%			79.813	79.331	77.522	
Water	%					2.870	

D

Sulfur dioxide, calc. 0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 110
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9713
F/A = 0.009998
Combustion efficiency = 97.78%

G

H

Measurement by N/A
Measurement at SAE AIR 1533 page 34
Date of measurement N/A
Engine S/N N/A

AESO 09-30-1987

Figure 4-2. Computer print-out of the data sheet for the gaseous emissions from an engine using the data of the sample calculation of SAE AIR 1533.

A	T56-A-16	MILITARY	File T56001M

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 97°F RH = 15% B = 29.86 in. Hg h = 0.008884 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	11.1	sd	7.0	6.9	6.8	0.65
	Carbon dioxide	%	2.21	sd	2.20	2.18	2.13	3229.31
	Oxides of nitrogen	ppm	67.1	sd	67.9	67.5	66.1	10.45
	Nitric oxide	ppm			65.8	65.4	64.0	10.12
	Nitrogen dioxide	ppm			2.1	2.1	2.1	0.33
	Hydrocarbons, $CH_{y/x}$	ppmC	2.9	w	3.0	3.0	2.9	0.14
	Hydrocarbons, CH_4							0.16
	Oxygen	%	17.6	sd	18.01	17.90	17.51	
	Nitrogen	%			79.79	79.30	77.58	
	Water	%					2.77	
D	Sulfur dioxide, calc.							0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	345
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	318

F

K = 0.9723
F/A = 0.010231
Combustion efficiency = 99.97%
Shaft horsepower = 4090
Engine speed = 13820 rpm
Engine exhaust temperature = 1970°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 2219 pounds per hour

Carbon monoxide	1.45
Carbon dioxide	7165.85
Oxides of nitrogen	23.18
Hydrocarbons, $CH_{y/x}$	0.31
Hydrocarbons, CH_4	0.35
Sulfur dioxide	0.89

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 23 JUNE 1976
Engine S/N 102138
Test Cell 11, single point probe in test cell exhaust stack.
JP-5 fuel.

AESO 09-30-1987

Figure 4-3. Computer print-out of the data sheet for the gaseous emissions from a T56-A-16 engine at military power.

Block A - A header shows

(1) the engine type indicator, type numerals, manufacturer's symbols and model indicator,

(2) the engine power setting, and

(3) the name of a data storage file.

The first three or four characters of the file name identify the engine type (e.g., T56, J79, F404). The next three characters, which usually are numbers or letters, give a unique designation to a group of power settings such as those used in the testing of an engine. A final letter indicates the power setting: I for idle; N for normal rated; X for maximum continuous; M for military, intermediate rated power, or takeoff; A for afterburner; B, C, D and other letters as needed, for power settings between idle and military. The AESO data sheets use the same identification of the power setting as recorded on the engine operational records at the place of the measurement. No print-out of a file name indicates that the computer program prepared the data sheet from entry of data into the program in response to inquiries appearing on the computer monitor.

Block B - This block has three groups of data.

The first group shows the instrument interference coefficients used in the calculation. A blank space means that matrix solution did not use instrument interference coefficients to adjust the measured concentrations of the constituents.

The second group shows terms related to humidity adjustments, namely,

(1) the ambient (dry bulb) temperature (T),

(2) the relative humidity (RH) (or the dew point temperature),

(3) the barometric pressure (B),

(4) the humidity of the inlet air (h), and

(5) the humidity of the exhaust sample (h_{sd}). For measurements giving a dew point temperature, the word 'DEW' replaces T and RH on the data sheet.

The third group of data shows the molecular constants of the fuel and the efficiency of the nitrogen dioxide/nitric oxide converter. Fuel analysis determines the molecular constants. Typically, the hydrogen (n) to carbon (m) ratio is about 2 for JP-4 fuel (n = 19 and m = 9.5), and about 1.8 for JP-5 fuel (n = 23.4 and m = 13.0).

Block C - For the constituents of the exhaust, a table shows the measured concentrations, the calculated dry, semi-dry and wet concentrations, and the emission indexes.

A notation after a measured concentration show the basis of the measurement, 'sd' for semi-dry and 'w' for wet. If the measurements did not include one for nitric oxide, the corresponding space is blank. The concentration of nitrogen dioxide is not measured. The matrix solution needs a value for the concentration of nitric oxide. If not measured, the computer program sets the concentration of nitric oxide at 97% of the concentration of the oxides of nitrogen. The calculation of the emission index from either of the hydrocarbon molecular weights uses the same concentration of hydrocarbons.

The matrix solution determines the values of the concentrations of the constituents and the emission indexes. Figure B3 of Appendix B shows details of these calculations. The matrix solution does not need the measured concentrations of oxygen, nitrogen and water. Some emission measurements include one for oxygen. If not measured, the corresponding space is blank.

Block D - The sulfur content of the fuel determines the emission index of sulfur dioxide. Sulfur appears in the exhaust mainly as sulfur dioxide. Although the emission index for sulfur dioxide can be calculated from a measured concentration, it is more convenient to calculate it from the sulfur content of the fuel. An aircraft fuel, such as JP-5, may contain as much as 0.4% of sulfur. Normally it contains about 0.02% (Reference 11). We assume that the entire sulfur content of the fuel is converted into sulfur dioxide at all power settings. Thus, for a fuel with a sulfur content of 0.02%, 1000 pounds of fuel contains 0.2 pounds of sulfur which is converted into 0.4 pounds of sulfur dioxde. The emission index for sulfur dioxide, at all engine power settings, is 0.40.

Block E - To have a uniform basis for the comparison of sources, some regulating agencies need to know the concentration of the oxides of nitrogen at an oxygen content other than the one measured. The following equation shows the conversion to a basis of 3% oxygen. Any concentration of oxygen may be substituted for the 3% concentration.

$$[NO_x] \text{ at } 3\% \text{ oxygen} = [NO_x]_m \quad \times \quad \frac{\text{oxygen in air } (\%) - 3\%}{\text{oxygen in air } (\%) - \text{oxygen in sample } (\%)}$$

where $[NO_x]_m$ is the measured concentration (ppm) of the oxides of nitrogen and the oxygen content of air is 20.948%. Then, adjusting a measured concentration of 66.1 ppm oxides of nitrogen in a sample containing 17.51% oxygen to a concentration in a sample with oxygen content of 3%:

$$[NO_x] \text{ at } 3\% \text{ oxygen} = 66.1 \quad \times \quad \frac{20.948 - 3}{20.948 - 17.51} = 345 \text{ ppm.}$$

Block E gives two values for the concentration of the oxides of nitrogen (wet basis) at 3% oxygen, one from the calculated concentration of oxygen and the other from the measured concentration of oxygen. The calculation from the measured concentration of oxygen first changes the concentration to a wet basis using the value of K from block F. For example, using equation (58) of SAE AIR 1533,

$$[O_2]_w = K \times [O_2]_{sd} \times (1 + h_{sd})$$

$$[O_2]_w = 0.9723 \times 17.6 \times 1.00607 = 17.22.$$

Block F - The entries in this block give the constant K, the fuel to air ratio and the combustion efficiency, as calculated by the matrix solution; and the thrust (or shaft horsepower), engine speed and engine exhaust temperature as reported in the engine operation records. Emission index calculations do not use engine speed or engine exhaust temperatures. In this Handbook the term engine exhaust temperature means the temperature, associated with the engine exhaust gas, as reported by the testing facility. For example this temperature may be the exhaust gas temperature for a J79 engine, but the turbine inlet temperature (T5) for a TF41 engine. The calculation of emission indexes may use a plot of thrust (or shaft horsepower) vs. emission index. See Paragraph 6.3.

Block G - After determining the emission indexes, the AESO computer program determines the emission rates using the emission indexes from Blocks C and D, and the fuel flow rates. If the data did not include fuel flow rates there is no calculation of emission rates and the corresponding space is blank. The emission rate of the pollutant is obtained by multiplying the fuel flow rate (in thousands of pounds) by the emission index. Note that the computer uses the emission index as a single precision number in calculating the emissions rates. The tables give the emission indexes rounded to two decimal places. This means that multiplying the emission index on the data sheet by the fuel rate may give a slightly different emission rate from the one recorded on the data sheet.

Block I - The reference part of the print-out tells who made the measurement, where and when, the engine serial number, the type of fuel used and optional information.

The date at the bottom of the sheet is 09-30-87 for all data sheets included in the first printing of this Handbook. Data sheets added after the first printing will show a later date.

4.5.2 Print-outs from Calculator Programs

Figure 4-4 shows print-outs from the calculator program AIRAP. These show only the most important emissions data. The instructions, in Appendix A, for program AIRAP explain the content of each line of the print-out. The user who needs additional print-out should modify the program.

Sample calculation
SAE AIR 1533
compare with Figure 4-2

```
0.09  -1.30-04   0.14
      -4.50-04   0.28

9.5 19.0 0.008843
     0.00607   0.95

500.0 2.00 20.0 9.0
225.0

                  EI
             CO = 47.65
            CO2 = 3076.41
            NOX = 3.37
     CXHY, CHY/X = 11.11
       CXHY, CH4 = 12.71

          CO WET = 483.3
         CO2 WET = 1.986
         NOX WET = 20.8
        CXHY WET = 225.0

  % OXYGEN, WET = 17.57
   NOX AT 3% 02 = 111
          WATER = 2.87%
           F/A =  0.009998
   COMB. EFF. =  97.78%
```

T56-A-16
military power
compare with Figure 4-3

```
-0.07  -1.00-04   0.14
       -3.30-04   0.28

13.0 23.4 0.008884
     0.00607   0.95

15   97  29.86

11.1 2.21 67.1 65.1
2.9  FUEL = 2219.0

                  EI
             CO = 0.65
            CO2 = 3229.32
            NOX = 10.45
     CXHY, CHY/X = 0.14
       CXHY, CH4 = 0.16

          CO WET = 6.8
         CO2 WET = 2.135
         NOX WET = 66.1
        CXHY WET = 2.9

  % OXYGEN, WET = 17.51
   NOX AT 3% 02 = 345
          WATER = 2.77%
           F/A =  0.010231
   COMB. EFF. =  99.97%

     POUNDS PER HOUR
             CO = 1.45
            CO2 = 7165.86
            NO2 = 23.18
          CHY/X = 0.31
            CH4 = 0.35
            SO2 = 0.89
```

Figure 4-4. Print-outs from program AIRAP.

4.6 Comparison of Calculations by Computers and Programmable Calculators

Table 4-1 compares the values of emission indexes determined by computers and programmable calculators. The difference in precision between the computer, used for the matrix solution, and the calculator, used for the solution of linear combustion equations, cause the small variations in the emission parameters. For practical use, the determinations by computers and programmable calculators are equivalent.

4.7 The Effect of Adjustments to Measured Concentrations on Emission Indexes

Table 4-2 shows how combinations of adjustments, to the measured concentrations of the constituents of an engine exhaust, affect the emission indexes. These adjustments are for the pressure broadening coefficient (J), the instrument interference coefficients (M, M' L, L'), the humidity (h and h_{sd}), the efficiency of the nitrogen dioxide to nitric oxide converter (η), and the ambient carbon dioxide concentration (T). Table 4-2 uses the data from the sample calculation in SAE AIR 1533 and the comprehensive matrix solution. An asterisk in a column indicates that the variable is at the value used in the sample calculation (for T this value is 0.00032). A zero in a column indicates a value of zero for J, L, L', M, M', h, h_{sd}, η, or T. For the converter efficiency, a zero means no correction, i.e., 100% efficiency.

Row 1 of Table 4-2 makes all of the adjustments to the measured concentrations and thus gives the emission indexes of the sample calculation. Other rows change one or more of the variables. For example, row 11 uses all of the instrument coefficients at zero. Row 23 makes none of the adjustments. Rows 14 and 15 compare the change in the emission index for the oxides of nitrogen when the converter efficiency is 95% or 100%. Obviously, only the emission index for the oxides of nitrogen changes. Rows 20, 21 and 22 show the effect when the water content of the inlet air varies.

The values of the instrument coefficients, J, L, L', M and M' are ones expected for infrared analyzers with filters in the optical system to suppress the effects of the interfering gases. For such analyzers, Table 4-2 shows that adjustments to measured concentrations of the constituents for humidity, instrument interferences and converter efficiency have only a small effect on the calculated emission indexes.

Table 4-1. Examples of emission indexes calculated from computer and calculator programs using the data of the sample calculation from SAE AIR 1533

Constituent	Emission index SAE AIR 1533 sample calculation (page 34)	Emission index computer or calculator program (method of calculation)			
		MATEI (matrix)	AIRAP (eqn. 3)[a]	AIRB (eqn. 2)[b]	AIRB (eqn. 2)[c]
Carbon monoxide	47.66	47.65	47.65	47.66	48.93
Carbon dioxide	3076.41[d]	3076.41	3076.41	3077.34	3075.23
Oxides of nitrogen	3.37	3.37	3.37	3.37	3.21
Hydrocarbons ($CH_{y/x}$)	11.11	11.11	11.11	-	-
Hydrocarbons (methane)	12.71[e]	12.71	12.70	12.71	12.61

[a] Program AIRAP uses the measured concentrations as inputs and adjusts them for the effects of humidity, instrument interference coefficients and the efficiency of the NO_x converter before calculating the emission indexes using equation (3) of Figure 4-1.

[b] Program AIRB uses equation (2) of Figure 4-1. In this example, before using equation (2), use equations (13), (14), (18), (20), and (58) of SAE AIR 1533 to adjust the concentrations of carbon monoxide, carbon dioxide and the oxides of nitrogen to a wet basis. The wet concentrations are: carbon monoxide, 483.3 ppm; carbon dioxide, 1.986%; oxides of nitrogen, 20.8 ppm. The hydrocarbon concentration (225 ppm) is measured on a wet basis and needs no adjustment. See Figures A1-1, A1-2 and A1-4 of Appendix A for details of these calculations.

[c] The emission indexes in this column come from the direct substitution of the measured concentrations into equation (2) without any adjustments, i.e, carbon monoxide, 500 ppm; carbon dioxide, 2%; oxides of nitrogen, 20 ppm and hydrocarbons, 225 ppm.

[d] SAE AIR 1533 does not report this calculation. It was calculated using P_1 from the list of P vectors on page 35 of SAE AIR 1533.

[e] SAE AIR 1533 does not report this calculation. It was calculated from equation (48) of SAE AIR 1533 and P_6 from the list of P vectors on page 35 of SAE AIR 1533.

Table 4-2. Effect of adjustments to concentrations on emission indexes

Row no.	J	L	L'	M	M'	h	h_{sd}	η	T	Emission indexes CO	CO_2	NO_x	CH_4
1	*	*	*	*	*	*	*	*	*	47.65	3076.41	3.37	12.71
2	0	*	*	*	*	*	*	*	*	48.41	3075.43	3.42	12.90
3	*	0	*	*	*	*	*	*	*	47.90	3076.02	3.37	12.70
4	*	*	0	*	*	*	*	*	*	48.65	3076.41	3.36	12.71
5	*	*	*	0	*	*	*	*	*	47.91	3076.01	3.37	12.70
6	*	*	*	*	0	*	*	*	*	47.65	3076.41	3.34	12.71
7	*	0	*	0	*	*	*	*	*	48.16	3075.61	3.37	12.70
8	*	*	0	*	0	*	*	*	*	47.65	3076.41	3.33	12.71
9	0	0	*	0	*	*	*	*	*	48.92	3074.64	3.42	12.90
10	0	*	0	*	0	*	*	*	*	48.41	3075.44	3.38	12.90
11	0	0	0	0	0	*	*	*	*	48.92	3074.63	3.38	12.90
12	0	0	0	0	0	0	*	*	*	48.93	3074.93	3.35	12.79
13	0	0	0	0	0	*	0	*	*	48.92	3074.72	3.40	12.98
14	0	0	0	0	0	0	0	*	*	48.93	3075.02	3.37	12.87
15	0	0	0	0	0	0	0	1	*	48.93	3075.02	3.28	12.87
16	0	0	0	0	0	*	*	*	0	48.17	3075.60	3.33	12.70
17	0	0	0	0	0	0	0	*	0	48.17	3075.94	3.32	12.67
18	0	0	0	0	0	*	*	1	*	48.92	3074.63	3.29	12.90
19	*	*	*	*	*	0	*	*	*	47.66	3076.70	3.33	12.60
20	*	*	*	*	*	0.005	*	*	*	47.66	3076.54	3.35	12.66
21	*	*	*	*	*	0.01	*	*	*	47.65	3076.37	3.37	12.72
22	*	*	*	*	*	0.015	*	*	*	47.65	3076.20	3.39	12.78
23	0	0	0	0	0	0	0	1	0	48.17	3027.08	3.23	12.67

5 EXAMPLES OF VARIATIONS OF EMISSION INDEXES

An emission index is not constant. An emission index varies during the operation of an engine at a power setting, especially as the engine is coming to a stable operating condition. An emission index varies for the same power setting at different times in a sequence of power settings, or among engines of the same type and model. Also both the performance of the instruments and the interpretation of the original data affect the emission index. This section uses examples of specific engine tests to show the variations of emission indexes (1) when sampling at the same position by two different laboratories, (Table 5-1), (2) when sampling at two different positions by two different laboratories (Table 5-2) and when sampling at two different position by the same laboratory (Table 5-3). This section also compares engine emissions with and without a ferrocene additive in the fuel (Table 5-4).

5.1 Variation of Gaseous Emissions at a Sampling Position

Table 5-1 shows the variations of emission indexes calculated from measurements by the mobile emissions laboratories of the Aircraft Environmental Support Office (AESO) and the Federal Aviation Administration (FAA). In this test a T58-GE-8F engine ran at various power settings during a three-day period. Samples from the test cell came from the same point in the exhaust stack through separate sample lines to each laboratory. For each power setting, a test-coordinator, in the test cell control room, announced one-minute read periods. These periods corresponded to intervals of stable engine operation, as specified by the operators of the engine. Each laboratory reported emission indexes for the read period. The test established 50 read periods for gaseous emissions. Table 5-1 gives the emission indexes at idle, high idle, approach, cruise and maximum continuous as determined by each laboratory, during 44 of the read periods. The FAA Laboratory did not measure at the takeoff power setting.

The data from this test, as reported in Reference 14, needed interpretation before they could be used for the comparison in Table 5-1. The test plan specified that each Laboratory report the concentrations of the constituents on a wet basis. The matrix solution for the emission index uses the concentrations of carbon monoxide and carbon dioxide on a semi-dry basis. For AESO data we used our original measurements which were stated on a semi-dry basis. For FAA data we adjusted the wet measurements to semi-dry using the values of K determined for each corresponding AESO measurement.

The test plan did not address the question of the adjustment of measured concentrations for instrument interferences prior to use in the calculation of the emission indexes. The calculations for Table 5-1 use the instrument interference coefficients for the AESO laboratory to adjust all concentrations. These modifications have little effect on what Table 5-1 shows, i.e., that emission indexes vary.

Finally, the test plan specified that participants use the vendor's certification for the concentration of each calibration gas. In Table 5-1, the AESO emission indexes for the oxides of nitrogen reference the measured concentrations to Standard Reference Materials 1683 and 1684 of the National Bureau of Standards (46.0 and 93.9 ppm nitric oxide in nitrogen) rather than to the vendor's certification.

5.2 Emission Indexes at Different Sampling Positions

Tables 5-2 and 5-3 compare the measured concentrations of the constituents and the calculated emissions data from sampling at two different positions. In Table 5-2 two different laboratories measured at different positions in the exhaust stream from a J52-P-6B engine. In Table 5-3 the same laboratory measured at two different positions in the exhaust stream of a T64-GE-7 engine.

In Table 5-2, the measuring position used by Scott Environmental Technology was at the exhaust plane of the engine and the measuring position of the Aircraft Environmental Support Office was in the test cell stack, 85 feet behind the engine exhaust plane. Each group used its own set of instruments. There was no correlation of read points. Each Laboratory reported one set of values for each power setting.

Table 5-2 shows that, as expected, the fuel to air ratio (F/A) is higher at the engine exhaust plane than in the test cell stack. Thus, the measured concentrations of the constituents are much higher in the Scott measurements. The next group of data in this table show that expressing the emissions as emission indexes and emission rates brings the values of the two sets of data close to one another.

These comparisons show that for estimates, the measurement of the emission index may be at the exhaust plane of the engine or elsewhere in the exhaust stream.

Table 5-3 continues this comparison using a measurement in which the Aircraft Environmental Support Office changed the sampling position by moving the sampling line, during operation at each of the power settings, between two sampling positions in the exhaust stream.

5.3 Effect of Ferrocene on Gaseous Emissions

Table 5-4 shows how the addition of ferrocene to JP-5 fuel changes the gaseous emissions from a J79-GE-8B engine. To make the calculations for Table 5-4, the Aircraft Environmental Support Office observed the effect of ferrocene on the concentrations of the gaseous emission. During the engine run, a solution containing ferrocene was pumped into the main fuel line while the engine was operating at all power settings above idle. At each power setting, the flow of the ferrocene solution was stopped for about one minute, then resumed. Chart recorders noted the change in the concentration of each constituent.

Table 5-1. Variation of emission indexes from a T58-GE-8F engine

Test Cell - 12
Location - Naval Air Rework Facility, North Island

IDLE

Date June 1979	Time	Reading number	Prior power setting	Emission index					
				Carbon monoxide		Oxides of nitrogen		Hydrocarbons (as methane)	
				AESO	FAA	AESO	FAA	AESO	FAA
5	1015	17	-	186.62	181.77	1.21	3.50	173.93	169.22
5	1225	27	HI	183.01	174.01	1.36	2.66	159.11	147.20
6	0833	28	I	175.95	175.23	1.19	2.51	151.46	155.15
6	0930	34	HI	173.19	178.02	1.42	2.54	147.65	143.02
6	1033	40	TO	182.50	188.33	1.40	2.68	146.88	143.36
7	0806	54	I	177.75	172.90	1.22	2.07	159.35	149.13
7	0939	64	HI	170.43	167.61	1.35	2.40	138.68	130.54
7	1155	65	I	178.44	170.70	1.43	2.39	151.34	141.55
7	1315	71	HI	172.77	170.47	1.47	2.55	136.60	129.09
7	1412	77	TO	176.69	172.43	1.40	2.20	136.50	129.26

HIGH IDLE

Date June 1979	Time	Reading number	Prior power setting	Emission index					
				Carbon monoxide		Oxides of nitrogen		Hydrocarbons (as methane)	
				AESO	FAA	AESO	FAA	AESO	FAA
5	1050	18	I	165.20	166.01	1.30	3.35	113.16	109.00
5	1215	26	AP	161.22	155.22	1.58	2.50	102.05	94.72
6	0927	33	AP	150.00	157.44	1.64	2.42	93.07	87.38
6	0955	35	I	153.04	159.31	1.65	2.57	96.37	92.11
6	1041	41	I	155.79	156.42	1.82	1.44	102.21	87.71
7	0815	55	I	152.36	151.68	1.62	2.37	97.09	92.69
7	0927	63	AP	147.12	149.48	1.57	2.39	86.15	80.57
7	1310	70	AP	145.25	150.90	1.69	2.47	84.63	80.63
7	1325	72	I	150.82	146.54	1.65	2.03	85.94	82.04
7	1427	78	I	152.43	152.27	1.63	2.27	89.45	85.60

NOTE: Code for prior power setting: I - idle, HI - high idle, CR - cruise, AP - approach, MC - maximum continuous, TO - takeoff.

Table 5-1. Variation of emission indexes from a T58-GE-8F engine (continued)

Test Cell - 12
Location - Naval Air Rework Facility, North Island

APPROACH

Date June 1979	Time	Reading number	Prior power setting	Emission index: Carbon monoxide AESO	Carbon monoxide FAA	Oxides of nitrogen AESO	Oxides of nitrogen FAA	Hydrocarbons (as methane) AESO	Hydrocarbons (as methane) FAA
5	1100	19	HI	15.72	16.57	3.98	4.36	2.02	1.49
5	1200	25	CR	15.91	16.76	4.37	4.60	1.34	0.79
6	0915	32	CR	16.15	17.47	4.52	4.63	0.94	1.04
6	1000	36	HI	17.79	18.88	4.67	4.81	1.47	1.58
7	0823	56	HI	17.28	17.68	4.47	4.45	1.30	1.32
7	0915	62	CR	16.39	16.71	4.31	4.28	1.14	0.95
7	1254	69	CR	16.05	16.96	4.42	4.71	1.01	0.85
7	1331	73	HI	17.68	18.15	4.41	4.19	1.24	1.21

CRUISE

Date June 1979	Time	Reading number	Prior power setting	Emission index: Carbon monoxide AESO	Carbon monoxide FAA	Oxides of nitrogen AESO	Oxides of nitrogen FAA	Hydrocarbons (as methane) AESO	Hydrocarbons (as methane) FAA
5	1110	20	AP	13.68	13.58	4.50	4.87	1.08	0.91
5	1150	24	MC	13.07	13.53	4.69	4.82	1.06	0.71
6	0905	31	MC	14.13	15.39	4.68	4.85	0.93	0.91
6	1010	37	AP	14.36	15.40	4.71	5.03	1.01	1.15
7	0831	57	AP	14.71	14.67	4.67	4.67	0.94	0.96
7	0910	61	MC	13.57	13.95	4.61	4.73	0.80	0.78
7	1246	68	MC	13.70	14.09	4.66	3.97	0.73	0.77
7	1339	74	AP	13.53	13.70	4.73	4.43	0.81	0.78

NOTE: Code for prior power setting: I - idle, HI - high idle, CR - cruise, AP - approach, MC - maximum continuous, TO - takeoff.

Table 5-1. Variation of emission indexes from a T58-GE-8F engine (concluded)

Test Cell - 12
Location - Naval Air Rework Facility, North Island

MAXIMUM CONTINUOUS

Date June 1979	Time	Reading number	Prior power setting	Emission index: Carbon monoxide AESO	Carbon monoxide FAA	Oxides of nitrogen AESO	Oxides of nitrogen FAA	Hydrocarbons (as methane) AESO	Hydrocarbons (as methane) FAA
5	1100	21	CR	11.96	12.20	4.75	5.03	0.85	0.73
5	1140	23	TO	13.16	13.54	4.78	4.95	1.13	0.88
6	0855	30	TO	11.27	11.75	4.88	5.01	0.54	0.82
6	1015	38	CR	13.53	14.26	5.02	5.28	0.96	1.06
7	0840	58	CR	12.96	13.52	4.90	4.93	0.85	0.84
7	0900	60	TO	11.43	11.72	4.94	4.96	0.59	0.63
7	1238	67	MC	12.00	12.08	4.92	4.36	0.71	0.71
7	1347	75	CR	12.38	-	4.95	-	0.63	-

TAKEOFF

Date June 1979	Time	Reading number	Prior power setting	Emission index: Carbon monoxide AESO	Carbon monoxide FAA	Oxides of nitrogen AESO	Oxides of nitrogen FAA	Hydrocarbons (as methane) AESO	Hydrocarbons (as methane) FAA
5	1130	22	MC	8.61	-	5.29	-	0.70	-
6	0840	29	I	8.97	-	5.05	-	0.48	-
6	1023	39	MC	9.24	-	5.61	-	0.48	-
7	0851	59	MC	9.86	-	5.42	-	0.54	-
7	1230	66	I	8.43	-	5.39	-	0.63	-
7	1407	65	I	9.03	-	5.47	-	0.46	-

NOTE: Code for prior power setting: I - idle, HI - high idle, CR - cruise, AP - approach, MC - maximum continuous, TO - takeoff.

Table 5-2. Gaseous emissions from a J52-P-6B engine, comparison of emissions at two different sampling positions

Power setting		Carbon monoxide ppm	Carbon dioxide %	Oxides of nitrogen NO_x ppm	Oxides of nitrogen NO ppm	Hydrocarbons ppmC	F/A
Idle	(AESO)	195.0	0.45	2.8	-	106.8	0.00212
Idle	(Scott)	615.89	1.24	10.66	10.26	289.00	0.006
3000 lbs Thrust	(AESO)	52.9	0.65	7.2	-	5.0	0.00294
Intermediate 1	(Scott)	185.24	1.58	21.74	20.38	29.50	0.008
75% Thrust	(AESO)	28.3	0.89	15.0	-	5.5	0.00406
Intermediate 2	(Scott)	96.95	2.20	40.04	38.68	15.90	0.011
Normal rated	(AESO)	25.3	1.04	22.3	-	5.5	0.00477
Normal	(Scott)	55.82	2.63	59.78	57.46	11.90	0.013
Military	(AESO)	19.2	1.13	29.2	-	3.5	0.00518
Military	(Scott)	37.64	2.96	79.04	76.73	10.20	0.014

Power setting		Fuel flow, lbs/hr	Thrust, lbs	Emission index, lbs/1000 lbs of fuel CO	CO_2	NO_x	CH_4
Idle	(AESO)	714	512	88.31	3196	2.12	28.33
Idle	(Scott)	715	511	93.68	2967	2.66	25.17
	(mean, Scott)	713	-	92.98	-	2.71	26.46
3000 lbs Thrust	(AESO)	2301	3034	16.57	3320	3.91	0.96
Intermediate 1	(Scott)	2308	3157	23.44	3141	4.52	2.14
	(mean, Scott)	2422	-	21.66	-	4.95	2.85
75% Thrust	(AESO)	3977	5446	6.07	3291	5.91	0.76
Intermediate 2	(Scott)	3997	5586	8.88	3167	6.02	0.83
	(mean, Scott)	4090	-	8.73	-	6.68	1.48
Normal rated	(AESO)	5366	7202	4.53	3276	7.48	0.65
Normal	(Scott)	5394	7355	4.29	3175	7.55	0.52
	(mean, Scott)	5444	-	4.48	-	8.02	0.96
Military	(AESO)	6328	8275	3.01	3271	9.00	0.38
Military	(Scott)	6347	8439	2.58	3178	8.89	0.40
	(mean, Scott)	6390	-	3.02	-	9.07	0.79

Table 5-2. Gaseous emissions from a J52-P-6B engine, comparison of emissions at two different sampling positions (concluded)

Power setting		Emissions, pounds per hour			
		CO	CO_2	NO_x	CH_4
Idle	(AESO)	63.05	2282	1.51	20.23
Idle	(Scott)	67.0	2122	1.90	18.0
	(mean, Scott)	71.5	-	2.09	20.5
3000 lbs Thrust	(AESO)	38.13	7639	9.01	2.20
Intermediate 1	(Scott)	51.4	7249	10.43	4.93
	(mean, Scott)	52.5	-	11.49	6.92
75% Thrust	(AESO)	24.14	13090	23.49	3.03
Intermediate 2	(Scott)	35.58	12660	24.08	3.33
	(mean, Scott)	35.7	-	27.35	5.20
Normal Rated	(AESO)	24.31	17581	40.14	3.49
Normal	(Scott)	23.2	17128	40.75	2.83
	(mean, Scott)	24.5	-	43.62	5.20
Military	(AESO)	19.02	20701	56.96	2.41
Military	(Scott)	16.4	20173	56.40	2.54
	(mean, Scott)	19.4	-	57.83	5.00

NOTE: Each power setting has two rows of data. The numbers in the first row are data obtained by the Aircraft Environmnetal Support Office. See data sheets for Files J52001I, J52001B, J52001C, J52001N and J52001M in Appendix C. The numbers in the second row are data obtained by Scott Environmental Technology as reported in Reference 15. The emissions testing was at Test Cell 15, Naval Air Rework Facility, Alameda on 17 June 1976. The Aircraft Environmental Support Office used a single point probe 85 feet behind the exhaust plane of the engine. Scott Environmental Technology used a probe at the exhaust plane of the engine. The 'read times' of the two groups was not correlated. The numbers in the third row of data are the means reported by Scott Environmental Technology for 7 observations during the testing of production engines. The tests by Scott Environmental Technology were performed under the direction of the Naval Air Propulsion Center.

Table 5-3. Gaseous emissions from a T64-GE-7 engine, comparison of emissions at two different sampling positions

Power setting	Sampling position	Carbon monoxide ppm	Carbon dioxide %	Oxides of nitrogen NO_x ppm	Oxides of nitrogen NO ppm	Hydrocarbons ppmC	F/A
Idle	(0.8')	576.7	2.09	19.1	-	274.1	0.01001
Idle	(40')	371.7	1.36	10.6	-	194.3	0.00652
75% Horsepower	(0.8')	53.8	3.06	84.7	-	6.6	0.01419
75% Horsepower	(40')	40.0	2.00	51.1	-	5.6	0.00926
Normal rated	(0.8')	44.4	3.37	105.5	-	8.2	0.01562
Normal rated	(40')	35.7	2.20	63.5	-	6.9	0.01019
Intermediate	(0.8')	45.9	3.64	126.9	-	8.2	0.01687
Intermediate	(40')	35.7	2.37	75.0	-	6.9	0.01098
Maximum	(0.8')	48.8	3.75	137.2	-	8.0	0.01737
Maximum	(40')	37.1	2.42	80.2	-	6.1	0.01121

Power setting	Sampling position	Fuel flow, lbs/hr	Shaft, hp	Emission index, lbs/1000 lbs of fuel CO	CO_2	NO_x	CH_4
Idle	(0.8')	262	81	53.38	3106	3.02	15.31
Idle	(40')	262	81	52.84	3129	2.52	16.71
75% Horsepower	(0.8')	1300	2697	2.08	3214	9.48	0.26
75% Horsepower	(40')	1300	2697	2.21	3231	8.79	0.34
Normal rated	(0.8')	1504	3279	1.19	3211	10.72	0.30
Normal rated	(40')	1504	3279	1.47	3228	9.92	0.38
Intermediate	(0.8')	1676	3729	1.10	3210	11.93	0.27
Intermediate	(40')	1676	3726	1.26	3225	10.87	0.35
Maximum	(0.8')	1731	3870	1.19	3209	12.51	0.26
Maximum	(40')	1731	3870	1.32	3224	11.02	0.31

Table 5-3. Gaseous emissions from a T64-GE-7 engine, comparison of emissions at two different sampling positions

Power setting		Emissions, pounds per hour			
		CO	CO_2	NO_x	CH_4
Idle	(0.8')	13.99	814	0.79	4.01
Idle	(40')	13.84	820	0.68	4.38
75% Horsepower	(0.8')	2.70	4178	12.32	0.34
75% Horsepower	(40')	2.88	4201	11.43	0.44
Normal rated	(0.8')	1.80	4830	16.12	0.45
Normal rated	(40')	2.46	5409	16.63	0.64
Intermediate	(0.8')	1.84	5379	19.99	0.46
Intermediate	(40')	2.11	5404	18.22	0.59
Maximum	(0.8')	2.06	5554	21.66	0.45
Maximum	(40')	2.29	5580	19.70	0.53

NOTE: Each power setting has two rows of data. The numbers in the first row are data obtained at a sampling position of 0.8 feet from the engine exhaust. The numbers in the second row are data obtained at a sampling position 40 feet behind the engine exhaust. The emissions testing was at Test Cell 9, Naval Air Rework Facility, North Island on 29 January 1974. See data sheets for Files T64002I, T64003I, T64002B, T64003B, T64002N, T64003N, T64002M, T64003M, T64002X, and T64003X in Appendix C.

Table 5-4. Gaseous emissions from a J79-GE-8B engine, comparison of emissions without and with ferrocene added to the fuel

Power setting		Carbon monoxide ppm	Carbon dioxide %	Oxides of nitrogen NO_x ppm	Oxides of nitrogen NO ppm	Hydrocarbons ppmC	F/A
Idle	(no ferrocene)	167.7	0.62	4.1	-	100.6	0.002903
75% rpm	(no ferrocene)	69.2	0.49	4.2	-	17.3	0.002203
75% rpm	(ferrocene)	88.9	0.49	3.2	-	25.7	0.002216
87% rpm	(no ferrocene)	23.4	0.73	11.5	-	2.2	0.003304
87% rpm	(ferrocene)	31.5	0.73	10.0	-	2.2	0.003308
90% rpm	(no ferrocene)	18.5	0.97	22.3	-	2.7	0.004431
90% rpm	(ferrocene)	25.9	0.97	20.8	-	2.7	0.004435
95% rpm	(no ferrocene)	15.8	1.01	24.5	-	1.1	0.004617
95% rpm	(ferrocene)	19.4	1.01	23.9	-	1.1	0.004619
Military	(no ferrocene)	16.3	1.08	32.9	-	1.6	0.004946
Military	(ferrocene)	20.9	1.08	30.7	-	1.6	0.004949

Power setting		Fuel flow, lbs/hr	Thrust, lbs	Emission index, lbs/1000 lbs of fuel CO	CO_2	NO_x	CH_4
Idle	(no ferrocene)	1188	233	55.18	3210.50	2.26	19.52
75% rpm	(no ferrocene)	1567	863	29.41	3345.65	3.05	4.42
75%	(ferrocene)	1567	863	37.86	3325.27	2.31	6.53
87% rpm	(no ferrocene)	4689	6015	6.07	3319.84	5.57	0.38
87% rpm	(ferrocene)	4689	6015	8.44	3315.94	4.84	0.37
90% rpm	(no ferrocene)	8213	9659	3.40	3286.69	8.05	0.34
90% rpm	(ferrocene)	8213	9659	5.01	3284.08	7.50	0.34
95% rpm	(no ferrocene)	8412	10291	2.69	3283.97	8.79	0.13
95% rpm	(ferrocene)	8412	10291	3.44	3282.76	8.27	0.13
Military	(no ferrocene)	9225	10939	2.59	3276.97	10.63	0.18
Military	(ferrocene)	9225	10939	3.49	3275.52	9.91	0.18

Table 5-4. Gaseous emissions from a J79-GE-8B engine, comparison of emissions with and without ferrocene added to the fuel (concluded)

Power setting		Emissions, pounds per hour CO	CO_2	NO_x	CH_4
Idle	(no ferrocene)	65.25	3814	2.69	23.19
75% rpm	(no ferrocene)	46.09	5243	4.78	6.93
75% rpm	(ferrocene)	59.33	5211	3.62	8.81
87% rpm	(no ferrocene)	28.48	15567	26.11	1.76
87% rpm	(ferrocene)	39.58	15548	22.68	1.76
90% rpm	(no ferrocene)	27.93	26994	66.08	2.82
90% rpm	(ferrocene)	41.18	26972	61.58	2.82
95% rpm	(no ferrocene)	22.61	27625	73.97	1.13
95% rpm	(ferrocene)	28.96	27615	69.58	1.13
Military	(no ferrocene)	23.92	30230	98.06	1.68
Military	(ferrocene)	32.21	30217	91.46	1.68

NOTE: See data sheets for Files J79002I, J79002B, J79002C, J79002D, J79002E, J79002M, J79F02B, J79F02C, J79F02D, J70F02E and J79F02M in Appendix C.

6 USE OF EMISSION INDEXES AND EMISSION RATES

The emission index, the fuel flow rate and the length of time at an engine power setting determine the amount of a constituent discharged to the atmosphere at any power setting. The emission index and the fuel flow rate may be expressed together as an emission rate. The addition of the amounts of each constituent from each power setting used in a test or an operating sequence determines the total amount of the constituent formed during that test/operation.

6.1 Calculation of Emissions

Equation (4) determines the amount of a constituent formed at any power setting.

$$W_z = EI_z \times F/1000 \times hr \qquad (4)$$

where W_z is the pounds (kilograms) of a constituent z produced by operation at the power setting for a specified time,

EI_z is the emission index of the constituent z in units of mass per 1000 units of mass of the fuel, i.e., pounds (kilograms) per 1000 pounds (kilograms) of fuel used,

F is the fuel flow rate at the power setting in pounds (kilograms) per hour, and

hr is the time in hours at the engine power setting.

The operation of an engine normally uses several different power settings. The summation of the amounts of the constituent from each power setting gives the amount of the constituent produced by operation at a group of power settings (i.e., an engine test).

The emissions data may include an emission rate such as pounds of constituent per hour. This emission rate can be used instead of the emission index to calculate the amount of a constituent formed.

Programs MATE1, AIRAP and AIRA calculate both emission indexes and emission rates.

6.2 Selection of Emission Indexes and Emission Rates

The tables of section 7 give emission indexes and emission rates at various power settings for specific engines. Typically, these tables include emission indexes and rates for the constituents of the exhaust at idle, at a high power setting such as military or IRP (intermediate rated power), at one or more power settings between idle and military, and at afterburner (if applicable). To calculate emissions for other engines of the same type at similar power settings, substitute appropriate values of the emission indexes from these tables. This assignment is an estimate as emission indexes for different engines of the same type may vary.

6.3 Selection of an Emission Index by Curve Fitting of Existing Data

If sufficient data exist, curve fitting using thrust and emission index as variables. defines a plot and generates descriptive constants. Then, these constants determine the emission index at any engine power setting from the measured thrusts. For example, the Naval Air Propulsion Center reported thrusts and emission indexes at 14 different power settings (Reference 13). Table F404.1 of section 7 records these data. The Aircraft Environmental Support Office used the Hewlett-Packard Advantage Advanced Solutions Pac to determine that the thrust vs. emission index plot, from 15% thrust to IRP, best fit an exponential curve. Paragraph A4.7 of Appendix A lists the data plotted. The curve fitting program generated constants a and b ($a = 2.983926$ and $b = 2.0093 \times 10^{-4}$) for use in the equation

$$y = ae^{bx},$$

where y = emission index and x = thrust in pounds.

The coefficient of determination was found to be 0.9983. Using the constants a and b, the preceding equation determines the emission index at any thrust level from 15% to IRP. For example solving this equation for y (emission index) using a thrust of 5945 pounds for a power setting of 89% rpm,

$$y = 2.9839\ e^{(2.0093 \times 10^{-4} \times 5945)} = 9.85.$$

Generally, the emission index and thrust at idle fit poorly on the curve describing the higher thrusts. The emission index for idle is best selected by the direct substitution of a known emission index. We also use direct substitution for the addition of afterburner data.

6.4 Sample Calculation

Table 6-1 records the emissions of the oxides of nitrogen from the simulated testing of an F404-GE-400 engine. It shows, for each power setting, an identification (column 1), a duration (column 2), a thrust (column 3), a fuel flow rate (column 4), an emission index as calculated by equation (4) or from direct substitution of a known value (column 5), the pounds of fuel used (column 6), and the pounds of the oxides of nitrogen produced at each power setting (column 7).

Equation (5) determines the amount of nitrogen dioxide produced at an engine power setting, for example at 89%,

$$W_z = 9.85 \times 4850/1000 \times 5/60 = 3.98.$$

Thrust values vary within limits from engine to engine and from test to test. This changes, slightly, the value of the emission index used. For example, in this table a power setting of IRP uses a thrust of 10,190 pounds and an emission index of 23.12. Reference 13 reports these values for IRP as 10,548 and 25.16

TABLE 6-1. Emissions of oxides of nitrogen from an F404-GE-400 Engine

Power setting	Time in mode, min.	Thrust, pounds	Fuel flow, pounds/hr.	Emission index	Fuel use per mode, pounds	Pounds of nitrogen dioxide/mode
Flight Idle	5	-	996	1.16	83.0	0.10
89% rpm	5	5945	4850	9.85	404.4	3.98
IRP	10	10190	8514	23.12	1419.0	32.81
Afterburner	3	-	29750	9.22	1487.5	13.71
		Pounds of fuel used in test			3394	
		Pounds of nitrogen dioxide per test				50.60
		Pounds of nitrogen dioxide per pound of fuel used in test				0.01491

NOTE: By convention, the oxides of nitrogen are expressed as if all of the oxides were nitrogen dioxide, i.e., the calculation of the emission index uses the concentration of the oxides of nitrogen and the molecular weight of nitrogen dioxide.

For the group of power settings, Table 6-1 concludes with a summation of (1) the pounds of fuel used, (2) the pounds of nitrogen dioxide formed per test, and (3) an emissions to fuel ratio, i.e., the pounds of the nitrogen dioxide produced for each pound of fuel used.

6.5 Use of an Averaging Technique to Estimate an Emission Rate

For the oxides of nitrogen, an averaging technique may be used to estimate an emission rate (pounds of constituent per pound of fuel). The use of this technique needs operational records (fuel flow rates and durations of operation at each power setting) from a group of tests which represent the testing of a specific engine at a test facility. The evaluation of each test as described in paragraph 6.4 gives an emissions-to-fuel ratio for each test. Averaging this ratio for all of the tests gives a mean value (correlation coefficient) for the amount of the oxides of nitrogen formed for each pound of fuel used. Then, for any test, multiply the total fuel used in the test by the correlation coefficient to get an estimate of the amount of the oxides of nitrogen formed during the test.

For a group of thirteen test of F404 engines at Naval Air Station Lemoore, the Aircraft Environmental Support Office (Reference 16) prepared a series of tables in the format of Table 6.1. The emissions-to-fuel ratios (pounds of oxides of nitrogen per pound of fuel) ranged from 0.01331 to 0.01742 with a mean value of 0.01556. This correlation coefficient can be used to estimate the amount of nitrogen dioxide produced in any test from the amount of fuel used.

7 SUMMARY TABLES OF GASEOUS EMISSIONS FROM AIRCRAFT ENGINES

The tables of this section summarize gaseous emissions data from aircraft engines. The purpose of these tables is to present, on a single page, the most significant emissions data for a group of power settings of an engine. The power settings are those which normally are used in the testing or the operation of an engine. Each table gives emissions data for a specific engine. In the opinion of the Aircraft Environmental Support Office, each table represents the data suitable for estimating emissions from other engines of the same type indicator and type numeral. The tables include emission indexes, fuel flow rates and emission rates. Thus, anyone knowing the engine run times at various power settings can estimate the total gaseous emissions from most of the gas turbine engines in the Navy inventory. Many users of this Handbook need only this section.

7.1 Engine Type Indicator/Numeral and Model Indicator

Whenever possible, a single table gives data suitable for use with all models of an engine type indicator/numeral. Some engines have tables for more than one model indicator. For example, the user of this Handbook consults Table J79.1 to estimate emissions from any J79-GE-8 or J79-GE-10/10A engine and Table J79.4 to estimate emissions from a J79-GE-10B engine. The J79-GE-10B engine has low smoke combustors. Emissions of carbon monoxide and hydrocarbons from it are significantly higher, at idle, than for the J79-GE-8/10 engines.

Another example of multiple tables for an engine type occurs for the T58 engine. The T58-GE-16 engine is rated at 1870 shaft horsepower with fuel consumption of about 1100 pounds per hour at military power. The T58-GE-8F engine is rated at 1350 shaft horsepower with fuel consumption of about 785 pounds per hour at military. The T58-GE-16 engine operates at a higher temperature than the T58-GE-8F engine and consequently produces greater amounts of the oxides of nitrogen.

7.2 Sources of Emissions Data

The summary tables use data obtained from emission measurements by the Aircraft Environmetal Support office and emissions data reported by other organizations. The selection of measurement data for the tables favors those data obtained by the Aircraft Environmental Support Office, because we knew the various details needed to apply the matrix method for the calculation of the emissions parameters.

7.2.1 Emissions Data from Sources other than the Aircraft Environmental Support Office

The summary tables prepared from the reports of other organizations record their data as presented. Normally these reports do not indicate how the the various adjustments were made to the measured concentrations.

7.2.2 Emissions Data from the Aircraft Environmental Support Office

For our emissions measurements, we intend to prepare a data sheet, such as shown as Figure 4-3 of paragraph 4.5.1, for each power setting of each engine test. At the date of the first printing of this Handbook some of our measurements had not yet been converted. The data sheet features a record of the measured concentrations of the constituents, all of the variables used to adjust them and the calculated emissions parameters from the matrix solution of the combustion equations.

The number of data sheets prepared for a test may be only one or two, representing a high and low power setting during a short test. By contrast, the operation of a single engine during an endurance test of eight hours may produce more than fifty data sheets for only five different power settings. Also, for any group of power settings, the emissions data may include a data sheet for each occurrence of a power setting or it may use a single data sheet to represent all occurrences of the power setting. We select from the data sheets the ones to be used for the preparation of the summary table.

7.3 Description of Summary Tables

The table number consists of the engine type indicator and type numeral, followed by a period and another number. This number serves only to distinguish one table from another. The engine manufacturer's symbol and model indicator appear in the captions of the tables. The caption contains either a reference to an AESO file or several words/characters coding a test by another group.

Each table contains three groups of data. Each table contains data entries as available.

The first group of data gives the measured concentrations needed to calculate the emission indexes. The column headers include the basis of measurement if known. The measured concentration tells nothing about the amount of correction needed for instrument interferences. Only Appendix C gives this information. For oxygen, this group gives the calculated and measured concentrations of oxygen.

The second group of data gives the engine operating data and the emission indexes of carbon monoxide, carbon dioxide, oxides of nitrogen, and hydrocarbons.

The third group of data gives the concentration of oxides of nitrogen expressed as if the concentration of oxygen in the exhaust were 3%, the emissions of the pollutants in pounds per hour, the combustion efficiency and the fuel/air ratio.

The table concludes with a record of who did the work, the place of the measurement, the date, the kind of measurement (test cell, test stand or airframe), position of probe and engine serial number.

Each table starts on an odd-numbered page. For groups of more than nine power settings, the table continues on the next page. Most summary tables fit on a single page.

The summary tables are arranged as follows:

turbofan engines - F101, F404, TF30, TF34, TF41;

turbojet engines - J52, J57, J65, J79, J85, LM1500, 7LM2500;

turboprop and turboshaft engines - T53, T56, T58, T64, T76, T400;

auxiliary power units - GTC85-72, GTPC95-2, GTCP100-54, Solar T-62T-27, WR27.

7.4 Description of Appendix C

If the Aircraft Environmental Support Office made the emissions measurements, Appendix C contains the data sheets used to prepare the tables of section 7. The Summary tables include the most important information from the data sheets of Appendix C. Those needing the instrument interference coefficients, humidity data, molecular constants for the fuel, converter efficiency, calculated dry/semi-dry/wet concentrations, calculated concentrations of water and nitrogen, calculated emissions of sulfur, the constant K, and engine exhaust temperatures must refer to the individual data sheets of Appendix C.

The pages of Appendix C are not numbered. An index at the beginning of the Appendix lists the data sheets it contains.

TABLE F101.1. GASEOUS EMISSIONS FROM AN F101DFE ENGINE (GE TM 82-697)

Reading number	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_X measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppm, wet	Oxygen meas., %	Oxygen calc., %
199	245.6	1.12	8.6	-	39.4	-	-
201	192.9	1.14	9.1	-	24.1	-	-
203	46.3	1.08	13.9	-	7.3	-	-
205	34.8	1.15	17.4	-	6.1	-	-
207	14.6	2.91	92.3	-	4.4	-	-
211	14.3	3.13	109.4	-	4.1	-	-
209	17.0	3.71	177.6	-	4.0	-	-
213	17.2	3.82	217.5	-	3.5	-	-

Reading number	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel			
				CO	CO_2	NO_X	Hydrocarbons
199	867	628	2305	44.2	-	2.58	4.1
201	947	731	2483	34.3	-	2.71	2.5
203	1558	1869	3877	8.9	-	4.44	0.8
205	1849	2447	4378	6.2	-	5.22	0.6
207	5880	9301	7219	1.0	-	10.90	0.2
211	6586	10369	7448	0.9	-	12.04	0.2
209	8872	13549	7992	0.9	-	16.54	0.1
213	10073	15083	8221	0.9	-	19.69	0.1

Reading number	Oxides of nitrogen, corrected to 3% oxygen, ppm,		Emissions, pounds per hour				Combustion efficiency, %	F/A
	meas.	calc.	CO	CO_2	NO_2	Hydrocarbons		
199	-	-	38.3	-	2.2	3.6	98.61	0.00537
201	-	-	32.5	-	2.6	2.4	98.98	0.00544
203	-	-	13.9	-	6.9	1.2	99.72	0.00506
205	-	-	11.5	-	9.7	1.1	99.80	0.00539
207	-	-	5.9	-	64.1	1.2	99.96	0.01377
211	-	-	5.9	-	79.3	1.3	99.96	0.01480
209	-	-	8.0	-	146.7	0.9	99.97	0.01753
213	-	-	9.1	-	198.3	1.0	99.97	0.01804

NOTE: Values in this table taken from S. P. Seto, Emission Characteristics of F101DFE Engine 5009003/4 at Ground Level, General Electric Technical Memorandum 82-697. Emission rates calculated by AESO from emission index and fuel flow rates.

TABLE F402.N1. GASEOUS EMISSIONS FROM AN F402 ENGINE (NAPC)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppm, wet	Oxygen meas., %	Oxygen calc., %
Idle	1075.2	1.770	10.7	-	376.4	-	-
85%	124.7	3.044	73.9	-	17.5	-	-
100%	56.4	3.956	175.9	-	11.6	-	-

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	Hydrocarbons
Idle	1137	589	-	106.3	2935.7	1.7	18.8
85%	6186	8871	-	8.2	3146.9	8.0	0.7
100%	10712	15084	-	2.7	3156.6	14.8	0.4

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	Hydrocarbons	Combustion efficiency, %	F/A
Idle	-	-	120.9	3337.9	1.9	21.4	-	-
85%	-	-	50.7	19466.7	49.5	4.5	-	-
100%	-	-	28.9	33813.5	158.5	4.4	-	-

NOTE: values in this table are preliminary data from NAPC using JP-5 fuel and a simulated altitude of 5,000 feet.

TABLE F404.N1. GASEOUS EMISSIONS FROM AN F404-GE-400 ENGINE (NAPC)

Power setting	Carbon monoxide measured, ppm	Carbon dioxide measured, %	Oxides of nitrogen NO_X measured, ppm	Oxides of nitrogen NO measured, ppm	Hydrocarbons measured, ppm	Oxygen meas., %	Oxygen calc., %
Ground idle	1352.1	1.721	6.9	-	1232.4	-	-
Flight idle	1046.7	1.518	-	-	811.3	-	-
15%	261.9	2.118	25.7	-	58.5	-	-
20%	139.1	2.297	32.0	-	30.0	-	-
26%	73.1	2.538	39.7	-	18.0	-	-
37%	62.3	2.899	56.5	-	15.0	-	-
46%	28.5	3.209	81.5	-	< 15.0	-	-
63%	21.2	3.677	131.3	-	< 15.0	-	-

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_X	Hydrocarbons
Ground idle	623.9	78	-	137.34	2747	1.16	58.18
Flight idle	814.8	234	-	123.52	2815	-	44.50
15%	1666.4	1597	-	24.49	3112	3.95	2.54
20%	1989.2	2069	-	12.09	3136	4.56	1.21
26%	2422.5	2782	-	5.77	3148	5.15	0.66
37%	3108.4	3845	-	4.31	3151	6.42	0.48
46%	4005.2	4883	-	1.78	3155	8.37	< 0.44
63%	5586.6	6662	-	1.16	3156	11.78	< 0.38

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	Hydrocarbons	Combustion efficiency, %	F/A
Ground idle	-	-	85.69	1714	0.72	36.30	-	-
Flight idle	-	-	100.64	2294	-	36.26	-	-
15%	-	-	40.81	5186	6.58	4.23	-	-
20%	-	-	24.05	6238	9.07	2.41	-	-
26%	-	-	13.98	7626	12.48	1.60	-	-
37%	-	-	13.40	9795	19.96	1.49	-	-
46%	-	-	7.13	12636	33.52	< 1.76	-	-
63%	-	-	6.48	17631	65.52	< 2.12	-	-

NOTE: values in this table are taken from Naval Air Propulsion Center letter NAPC-LR-81-10 of 30 November 1981; except emissions, pounds per hour, which were calculated from emission indexes and fuel flow rates.

TABLE F404.N2. GASEOUS EMISSIONS FROM AN F404-GE-400 ENGINE (NAPC)

Power setting	Carbon monoxide measured, ppm	Carbon dioxide measured, %	Oxides of nitrogen NO_X measured, ppm	Oxides of nitrogen NO measured, ppm	Hydrocarbons measured, ppm	Oxygen meas., %	Oxygen calc., %
76%	21.7	3.988	178.9	-	<15.0	-	-
Max. cont.	25.0	4.304	244.1	-	<15.0	-	-
94%	26.8	4.423	286.7	-	<15.0	-	-
IRP	24.0	4.579	349.2	-	<15.0	-	-
A/B min.	1678.7	4.300	281.4	-	354.0	-	-
A/B mid.	1704.4	7.550	296.6	-	311.0	-	-
A/B max.	1234.3	10.610	299.2	-	15.0	-	-

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_X	Hydrocarbons
76%	6541.3	8031	-	1.09	3156	14.80	< 0.35
Max. cont.	7495.1	9201	-	1.17	3156	18.71	< 0.33
94%	8082.6	9957	-	1.22	3156	21.38	< 0.32
IRP	8586.9	10548	-	1.05	3156	25.16	< 0.31
A/B min.	10250.0	10996	-	74.95	2017	20.64	7.35
A/B mid.	19071.0	14110	-	44.21	2077	12.64	3.75
A/B max.	28396.5	15254	-	23.12	3122	9.22	0.13

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	Hydrocarbons	Combustion efficiency, %	F/A
76%	-	-	7.13	20644	96.81	< 2.29	-	-
Max. cont.	-	-	8.77	23655	140.23	< 2.27	-	-
94%	-	-	9.86	25509	172.81	< 2.59	-	-
IRP	-	-	9.02	27100	216.05	< 2.66	-	-
A/B min.	-	-	768.24	20674	211.56	75.34	-	-
A/B mid.	-	-	843.13	39610	241.06	71.52	-	-
A/B max.	-	-	656.53	88654	261.82	3.69	-	-

NOTE: values in this table are taken from Naval Air Propulsion Center letter NAPC-LR-81-10 of 30 November 1981; except emissions, pounds per hour, which were calculated from emission indexes and fuel flow rates.

TABLE TF30.1. GASEOUS EMISSIONS FROM A TF30-P-6C ENGINE
(SUMMARY OF FILES TF30020I, TF30020B, TF30020C, TF30020N, TF30020M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_x measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	116.9	0.35	2.0	-	42.2	-	20.25
30% Thrust	35.9	0.49	6.5	-	8.3	-	20.05
75% Thrust	17.2	0.66	13.7	-	3.3	-	19.79
Normal rated	11.2	0.78	21.8	-	5.1	-	19.61
Military	10.1	0.97	36.8	-	8.3	-	19.33

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_x	$CH_{y/x}$	CH_4
Idle	670	645	-	70.58	3339.56	2.03	12.92	14.99
30% Thrust	2030	3400	-	14.87	3376.83	4.77	1.84	2.13
75% Thrust	3560	6275	-	4.75	3337.67	7.38	0.54	0.62
Normal rated	4830	8395	-	2.31	3314.95	9.86	0.70	0.81
Military	6700	11025	-	1.56	3287.67	13.28	0.91	1.05

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour				Combustion efficiency, %	F/A
			CO	CO_2	NO_2	CH_4		
Idle	-	51	47.29	2237.50	1.36	10.04	97.07	0.001577
30% Thrust	-	129	30.19	6854.97	9.68	4.33	99.47	0.002182
75% Thrust	-	212	16.92	11882.12	26.26	2.22	99.84	0.002972
Normal rated	-	291	11.18	16011.20	47.64	3.91	99.88	0.003535
Military	-	405	10.48	22027.41	88.98	7.05	99.87	0.004430

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 15, Naval Air Rework Facility, Alameda on 1 July 1976, single point probe, 85 feet behind the engine. Engine serial number 652061.

TABLE TF30.2. GASEOUS EMISSIONS FROM A TF30-P-412A ENGINE
(SUMMARY OF FILES TF30021I, TF30021B, TF30021N, TF30021M, TF30021A)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_x	NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	64.7	0.25	2.2	-	71.1	-	20.37
75% Thrust	9.6	0.46	13.6	-	6.2	-	20.06
Normal rated	6.7	0.56	25.0	-	6.2	-	19.91
Military	6.7	0.64	35.2	-	4.6	-	19.79
Afterburner Z5	246.6	4.57	64.4	-	8.8	-	14.06

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_x	$CH_{y/x}$	CH_4
Idle	920	595	10278	55.51	3440.59	3.22	31.42	36.46
75% Thrust	4300	7070	13441	3.43	3413.00	10.74	1.48	1.72
Normal rated	5980	9550	14105	1.62	3371.58	16.02	1.20	1.39
Military	7050	10900	14505	1.38	3347.82	19.60	0.77	0.90
Afterburner Z5	47800	18850	14460	10.77	3188.56	4.79	0.20	0.24

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	69	51.07	3165.34	2.96	33.54	95.57	0.001094
75% Thrust	-	275	14.74	14675.89	46.19	7.38	99.77	0.002027
Normal rated	-	431	9.66	20162.07	95.82	8.34	99.84	0.002497
Military	-	544	9.71	23602.14	138.20	6.34	99.89	0.002874
Afterburner Z5	-	162	514.91	152413.20	229.04	11.31	99.73	0.021252

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 16, Naval Air Rework Facility, Alameda on 24 June 1976, single point probe, 85 feet behind the engine. Engine serial number 679326.

TABLE TF34.1. GASEOUS EMISSIONS FROM A TF34-GE-400 ENGINE
(SUMMARY OF FILES TF34001I, TF34001B, TF34001M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_x measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	211.9	0.41	2.0	-	58.9	-	20.14
75% rpm	102.2	0.44	4.2	-	10.7	-	20.10
Military	60.2	0.81	17.3	-	3.0	-	19.55

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_x	$CH_{y/x}$	CH_4
Idle	485	950	11600	90.98	3248.66	1.69	14.99	17.40
75% rpm	460	960	12000	33.57	3369.69	3.42	2.63	3.06
Military	3800	9275	16500	5.95	3304.70	7.51	0.39	0.46

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	Oxides of nitrogen, corrected to 3% oxygen, ppm, calc.	Emissions, pounds per hour				Combustion efficiency, %	F/A
			CO	CO_2	NO_2	CH_4		
Idle	-	44	44.13	1575.60	0.82	8.44	96.39	0.001899
75% rpm	-	89	15.44	1550.06	1.58	1.41	98.96	0.001964
Military	-	221	22.62	12557.87	28.56	1.74	99.82	0.003682

Emissions measurements by the Aircraft Environmental Support Office at TF34 Test Cell, Naval Air Station, North Island on 29 January 1974, single point probe. Engine serial number 202110.

TABLE TF41.1. GASEOUS EMISSIONS FROM A TF41-A-2 ENGINE
(SUMMARY OF FILES TF410011, B, C, D, E, N, and TF41003M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	267.3	0.55	2.9	-	287.1	-	19.90
8000 rpm	236.5	0.53	3.6	-	201.8	-	19.93
9000 rpm	166.3	0.56	4.7	-	124.5	-	19.90
10000 rpm	121.4	0.59	6.2	-	73.0	-	19.86
75% Max. cont.	12.4	0.93	44.7	-	6.4	-	19.36
90% Max. cont.	11.0	1.04	67.5	-	8.2	-	19.19
Intermediate	12.4	1.19	76.8	-	7.2	19.0	18.92

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	1090	595	7100	94.80	3050.49	1.71	51.26	59.48
8000 rpm	1230	820	8000	88.70	3112.35	2.25	38.14	44.26
9000 rpm	1500	1210	9020	60.41	3200.23	2.86	22.90	26.58
10000 rpm	1880	1800	10029	42.30	3253.88	3.64	12.96	15.04
75% Max. cont.	6000	9550	12056	2.17	3292.14	16.85	0.73	0.85
90% Max. cont.	7480	11500	12460	1.62	3280.21	22.67	0.84	0.97
Intermediate	8940	14000	-	1.64	3267.64	22.46	0.64	0.74

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	49	103.33	3325.03	1.87	64.83	92.67	0.002711
8000 rpm	-	63	109.10	3828.19	2.77	54.43	94.13	0.002561
9000 rpm	-	80	90.62	4800.34	4.29	39.86	96.31	0.002631
10000 rpm	-	101	79.53	6117.30	6.84	28.28	97.72	0.002726
75% Max. cont.	-	500	13.01	19752.85	101.09	5.09	99.88	0.004242
90% Max. cont.	-	684	12.15	24535.96	169.56	7.25	99.88	0.004759
Intermediate	594	671	14.63	29212.69	200.76	6.65	99.90	0.005464

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 15, Naval Air Rework Facility, Alameda on 24 June and 8 July 1976, single point probe. 85 feet behind the engine exhaust. Engine serial numbers 141917/141369.

TABLE J52.1. GASEOUS EMISSIONS FROM A J52-P-6B ENGINE
(SUMMARY OF FILES J52001I, J52001B, J52001C, J52001N, J52001M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry NO_X	Oxides of nitrogen measured, ppm, semi-dry NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	195.0	0.46	2.8	-	106.8	20.3	20.03
3000 lbs Thrust	52.9	0.65	7.2	-	5.0	20.1	19.76
75% Thrust	28.3	0.90	15.0	-	5.5	19.9	19.39
Normal rated	25.3	1.04	22.3	-	5.5	-	19.18
Military	19.2	1.13	29.2	-	3.5	19.7	19.05

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	714	512	6926	86.37	3196.13	2.07	23.88	27.71
3000 lbs Thrust	2301	3034	9770	16.57	3319.80	3.91	0.82	0.96
75% Thrust	3977	5446	10641	6.00	3290.12	5.84	0.65	0.75
Normal rated	5366	7202	11177	4.53	3276.40	7.48	0.56	0.65
Military	6328	8275	11500	3.01	3271.29	9.00	0.33	0.38

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	59	54	61.67	2282.03	1.48	19.79	95.61	0.002165
3000 lbs Thrust	119	108	38.13	7638.86	9.01	2.20	99.53	0.002943
75% Thrust	202	171	23.85	13084.82	23.22	3.00	99.80	0.004108
Normal rated	-	224	24.31	17581.18	40.14	3.49	99.84	0.004765
Military	333	273	19.02	20700.70	56.96	2.41	99.90	0.005183

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 15, Naval Air Rework Facility, Alameda on 17 June 1976, single point probe, 85 feet behind the engine. Engine serial number 649773.

TABLE J52.10. GASEOUS EMISSIONS FROM A J52-P-8B ENGINE
(SUMMARY OF FILES J52010I, J52010MI, J52010B, J52010C, J52010N, J52010M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_X measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	149.1	0.47	2.5	-	194.6	20.2	20.02
Manual idle	139.1	0.40	2.2	-	221.7	-	20.13
3000 lbs Thrust	36.1	0.68	12.2	-	10.9	19.9	19.72
75% Thrust	17.0	0.99	28.6	-	5.4	19.5	19.26
Normal rated	8.3	1.23	42.9	-	6.9	19.4	18.90
Military	8.1	1.40	52.7	-	12.3	19.1	18.65

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	680	475	6625	63.78	3166.50	1.79	42.20	48.96
Manual idle	640	-	6350	69.51	3149.76	1.84	56.16	65.16
3000 lbs Thrust	2300	3005	9866	10.54	3319.15	6.34	1.72	1.99
75% Thrust	4320	5900	10869	3.00	3284.13	10.10	0.58	0.67
Normal rated	6130	8030	11478	0.87	3266.06	12.13	0.59	0.69
Military	7370	9200	11906	0.71	3254.59	13.05	0.93	1.08

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	47	48	43.37	2153.22	1.22	33.30	94.30	0.002233
Manual idle	-	48	44.48	2015.85	1.18	41.70	92.77	0.001911
3000 lbs Thrust	170	177	24.23	7634.04	14.58	4.58	99.58	0.003079
75% Thrust	294	301	12.98	14187.45	43.64	2.90	99.87	0.004526
Normal rated	408	372	5.35	20020.96	74.36	4.22	99.92	0.005649
Military	426	406	5.22	23986.31	96.16	7.93	99.89	0.006449

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 15, Naval Air Rework Facility, Alameda on 29 June 1976, single point probe, 85 feet behind the engine. Engine serial number 661421.

TABLE J52.20. GASEOUS EMISSIONS FROM A J52-P-408 ENGINE (NAPC Scott)

Power setting	Carbon monoxide measured, ppm	Carbon dioxide measured, %	Oxides of nitrogen NO_x measured, ppm	Oxides of nitrogen NO measured, ppm	Hydrocarbons measured, ppm	Oxygen meas., %	Oxygen calc., %
Idle	361.98	1.24	9.39	9.20	320.00	-	-
Intermediate 1	92.59	1.68	31.29	28.17	20.40	-	-
Intermediate 2	44.27	2.82	71.08	67.23	16.30	-	-
Normal	31.59	3.28	101.70	99.11	17.40	-	-
Military	26.88	3.70	137.18	137.18	18.20	-	-

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_x	Hydrocarbons
Idle	779	548	-	55.96	3018	2.38	28.33
Intermediate 1	2547	3420	-	11.12	3162	6.17	1.40
Intermediate 2	5752	7629	-	3.18	3177	8.38	0.67
Normal	8078	10142	-	1.95	3179	10.29	0.61
Military	9479	11349	-	1.47	3180	12.32	0.57

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	Hydrocarbons	Combustion efficiency, %	F/A
Idle	-	-	43.6	2351	1.86	22.07	-	0.006
Intermediate 1	-	-	28.3	8054	15.71	3.57	-	0.008
Intermediate 2	-	-	18.3	18272	48.21	3.85	-	0.014
Normal	-	-	15.7	25678	83.13	4.96	-	0.016
Military	-	-	13.9	30104	116.76	5.40	-	0.018

NOTE: values in this table are taken from Scott Env. Tech., Individual Engine Test & Model Summary Reports, Mod. 6, Alameda Testing, USAF Contract F29601-75-C-46, October 20, 1976.

TABLE J57.1. GASEOUS EMISSIONS FROM A J57-P-10 ENGINE
(SUMMARY OF FILES J57001I, J57001B, J57001N, J57001M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_x measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	237.4	0.55	3.3	-	564.3	-	19.87
75% Thrust	18.3	1.01	21.4	-	7.2	-	19.21
Normal rated	13.0	1.16	30.0	-	11.0	19.0	18.99
Military	10.2	1.26	37.6	-	10.3	19.0	18.84

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_x	$CH_{y/x}$	CH_4
Idle	1100	555	6009	80.52	2920.94	1.87	96.60	112.10
75% Thrust	5670	7040	8958	3.21	3281.02	7.40	0.76	0.88
Normal rated	7250	9050	9267	1.79	3268.55	9.00	1.00	1.16
Military	8370	10310	9468	1.16	3262.61	10.37	0.86	1.00

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	55	88.57	3213.04	2.05	123.31	88.47	0.002831
75% Thrust	-	219	18.20	18603.40	41.97	4.98	99.85	0.004621
Normal rated	235	272	13.00	23696.99	65.26	8.44	99.86	0.005325
Military	292	316	9.74	27308.07	86.78	8.40	99.89	0.005792

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 15, Naval Air Rework Facility, Alameda on 9 July 1976, single point probe, 85 feet behind the engine. Engine serial number 606306.

TABLE J57.21. GASEOUS EMISSIONS FROM A J57-P-420 ENGINE
(SUMMARY OF FILES J57021I, J57021B, J57021C, J57021D, J57021N, J57021M, J57021A)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	252.2	0.56	2.7	-	444.2	-	19.83
30% Thrust	63.5	0.65	8.2	-	27.6	-	19.72
75% Thrust	36.5	0.82	16.3	-	8.4	-	19.46
96% rpm	27.0	1.00	27.4	-	10.2	-	19.20
Normal rated	27.0	0.98	25.7	-	6.5	-	19.23
Intermediate	24.1	1.21	45.1	-	5.6	-	18.89
Afterburner	336.1	4.29	65.4	-	103.0	-	14.40

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	1322	393	6794	80.74	2985.39	1.53	76.46	88.73
30% Thrust	3413	3577	8407	14.83	3310.23	4.45	4.54	5.27
75% Thrust	5767	6946	9090	4.32	3303.38	6.99	1.09	1.27
96% rpm	7667	9139	9569	1.17	3284.34	9.58	1.09	1.26
Normal rated	7701	9241	9508	1.23	3287.72	9.18	0.71	0.82
Intermediate	10570	12007	10090	0.34	3268.72	12.97	0.49	0.57
Afterburner	39721	18240	10085	14.20	3177.14	5.16	2.54	2.94

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	Oxides of nitrogen, corrected to 3% oxygen, ppm, calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	43	106.74	3946.69	2.03	117.29	90.48	0.002821
30% Thrust	-	118	50.62	11297.80	15.17	17.98	99.20	0.002952
75% Thrust	-	195	24.91	19050.60	40.32	7.33	99.79	0.003729
96% rpm	-	277	8.96	25181.04	73.46	9.65	99.86	0.004571
Normal rated	-	265	9.49	25318.72	70.70	6.31	99.90	0.004475
Intermediate	-	387	3.58	34550.36	137.13	6.02	99.94	0.005553
Afterburner	-	173	563.93	126199.20	205.13	116.87	99.42	0.020041

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 20, Naval Air Rework Facility, North Island on 16 January 1974, single point probe, 95 feet behind the engine. Engine serial number 634012.

TABLE J65.1. GASEOUS EMISSIONS FROM A J65-W-5F ENGINE
(SUMMARY OF FILES J65001I, J65001B, J65001C, J65001D, J65001M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_X measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	201.7	0.87	6.3	-	82.5	20.0	19.44
7450 rpm	55.9	0.89	18.6	-	8.0	18.8	19.42
8000 rpm	41.3	1.09	17.9	-	7.4	-	19.13
8300 rpm	29.7	1.22	18.1	-	3.8	-	18.93
Military	35.6	1.28	19.3	-	7.4	19.5	18.84

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	1320	450	4020	47.16	3196.99	2.46	9.78	11.35
7450 rpm	4370	4710	7450	12.61	3279.73	7.30	0.95	1.10
8000 rpm	5970	6380	8000	7.39	3266.45	5.71	0.72	0.83
8300 rpm	7040	7330	8300	4.57	3261.68	5.15	0.33	0.38
Military	6946	7250	8311	5.31	3255.43	5.23	0.61	0.71

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	94	74	62.25	4220.02	3.25	14.98	97.93	0.004087
7450 rpm	139	217	55.11	14332.42	31.89	4.82	99.61	0.004075
8000 rpm	-	175	44.13	19500.71	34.10	4.96	99.76	0.005008
8300 rpm	-	160	32.19	22962.25	36.28	2.68	99.86	0.005611
Military	195	163	36.86	22612.21	36.31	4.91	99.82	0.005897

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 1, Naval Air Rework Facility, Alameda on 22 June 1976, single point probe. Engine serial number 603118.

04-03-1996

TABLE J79.1. GASEOUS EMISSIONS FROM A J79-GE-8D ENGINE
(SUMMARY OF FILES J79001I, J79001B, J79001C, J79001D, J79001M, J79020A)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry		Hydrocarbons measured, ppmC, wet	Oxygen	
			NO_x	NO		meas., %, semi-dry	calc., %, wet
Idle	169.3	0.62	4.3	-	101.7	-	19.84
75% rpm	72.0	0.49	4.1	-	20.1	-	20.04
87% rpm	24.3	0.72	11.4	-	2.0	-	19.70
90% Nor. rated	16.8	0.96	23.2	-	1.0	-	19.34
Military	13.5	1.07	32.0	-	1.4	-	19.18
Afterburner	281.3	3.81	52.9	-	32.7	15.7	15.10

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_x	$CH_{y/x}$	CH_4
Idle	1205	259	5012	55.70	3209.27	2.37	16.93	19.64
75% rpm	1520	1022	5763	30.61	3341.62	2.98	4.40	5.11
87% rpm	4545	5933	6662	6.43	3321.47	5.60	0.30	0.34
90% Nor. rated	8206	9700	7155	3.06	3289.04	8.46	0.11	0.13
Military	9453	10838	7690	2.07	3278.84	10.44	0.14	0.16
Afterburner	34315	17222	7464	13.25	3186.92	4.72	0.91	1.05

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm,		Emissions, pounds per hour				Combustion efficiency, %	F/A
	meas.	calc.	CO	CO_2	NO_2	CH_4		
Idle	-	69	67.12	3867.17	2.86	23.67	97.01	0.002904
75% rpm	-	81	46.53	5079.26	4.52	7.77	98.85	0.002205
87% rpm	-	163	29.23	15096.06	25.45	1.57	99.82	0.003257
90% Nor. rated	-	257	25.15	26989.87	69.45	1.05	99.92	0.004382
Military	-	322	19.54	30994.88	98.70	1.52	99.94	0.004898
Afterburner	156	157	454.56	109359.20	161.87	36.05	99.60	0.017773

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 20, Naval Air Rework Facility, North Island, 10 May 1977 and 12 June 1974, single point probe, 95' behind engine. Engine serial numbers 401917 and 433996.

TABLE J79.10. GASEOUS EMISSIONS FROM A J79-GE-10B ENGINE
(SUMMARY OF FILES J79BB01I, J79BB01B, J79BB01C, J79BB01D, J79BB01M, J79BB01A)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_x measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	415.6	0.70	2.9	-	281.1	20.0	19.63
30% Thrust	67.9	0.57	6.8	-	15.6	20.2	19.86
85% rpm	57.6	0.66	8.6	-	14.3	20.1	19.73
75% Thrust	31.3	0.99	23.4	-	14.9	19.7	19.24
Intermediate	29.3	1.19	35.1	-	13.6	19.4	18.94
Afterburner	294.3	3.70	49.1	-	18.3	15.7	15.27

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_x	$CH_{y/x}$	CH_4
Idle	1250	265	5077	111.41	3023.18	1.33	39.19	45.47
30% Thrust	3422	3381	6340	20.04	3331.43	4.23	2.94	3.41
85% rpm	3640	4243	6496	13.63	3317.03	4.60	2.32	2.69
75% Thrust	7578	9000	7171	2.74	3281.22	8.26	1.60	1.85
Intermediate	10000	11248	7475	1.60	3265.84	10.26	1.21	1.40
Afterburner	35000	17500	7475	14.56	3186.88	4.51	0.52	0.60

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour				Combustion efficiency, %	F/A
			CO	CO_2	NO_2	CH_4		
Idle	44	39	139.26	3778.97	1.67	56.84	93.50	0.003480
30% Thrust	121	112	68.59	11400.14	14.48	11.67	99.24	0.002573
85% rpm	142	126	49.63	12074.00	16.75	9.79	99.45	0.002991
75% Thrust	270	243	20.74	24865.06	62.58	14.04	99.78	0.004530
Intermediate	333	311	15.97	32658.38	102.58	14.03	99.84	0.005467
Afterburner	145	150	509.57	111540.90	157.78	21.15	99.61	0.017267

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 19, Naval Air Rework Facility, North Island on 12 June 1974, single point probe. Engine serial number 433421.

TABLE J85.N1. GASEOUS EMISSIONS FROM A J85-GE-2 ENGINE (NAPC-F973)

Power setting	Carbon monoxide measured, ppm	Carbon dioxide measured, %	Oxides of nitrogen NO_x measured, ppm	Oxides of nitrogen NO measured, ppm	Hydrocarbons measured, ppm	Oxygen meas., %	Oxygen calc., %
Ground idle	>1500	2.50	30	28	318	-	-
15%*	1330	2.44	27	22	148	-	-
20%*	1267	2.44	27	21	130	-	-
30%*	832	2.45	31	22	61	-	-
40%*	680	2.51	35	24	44	-	-
60%*	505	2.77	44	31	27	-	-

Power setting	Fuel flow, lb/hr	Thrust, lb	EGT, °F.	Emission index, lb/1000 lb of fuel CO	CO_2	NO_x	Hydrocarbons
Ground idle	560	200	945	>111.86	-	3.68	11.86
15%*	785	503	838	102.79	-	3.43	5.72
20%*	810	540	840	98.23	-	3.44	5.04
30%*	1045	838	857	65.53	-	4.02	2.40
40%*	1220	1062	867	52.66	-	4.46	1.70
60%*	1700	1658	950	35.78	-	5.13	0.959

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	Hydrocarbons	Combustion efficiency, %	F/A
Ground idle	-	-	> 62.64	-	2.06	6.64	-	0.01219
15%*	-	-	80.69	-	2.69	4.49	-	0.01119
20%*	-	-	79.57	-	2.79	4.08	-	0.01112
30%*	-	-	68.48	-	4.20	2.51	-	0.01144
40%*	-	-	64.25	-	5.44	2.08	-	0.01204
60%*	-	-	60.82	-	8.72	1.63	-	0.01377

* Normal rated power

NOTE: values in this table are taken from Naval Air Propulsion Test Center letter PE71:GES:ss, 10340 SER F973, of 24 April 1974.

TABLE J85.N2. GASEOUS EMISSIONS FROM A J85-GE-2 ENGINE (NAPC-F973)

Power setting	Carbon monoxide measured, ppm	Carbon dioxide measured, %	Oxides of nitrogen NO_X measured, ppm	Oxides of nitrogen NO measured, ppm	Hydrocarbons measured, ppm	Oxygen meas., %	Oxygen calc., %
75%*	445	3.09	54	37	20	-	-
90%*	420	3.44	65	44	18	-	-
90%**	418	3.48	66	45	17	-	-
Normal rated	412	3.74	73	50	17	-	-
Military	410	3.76	74	51	17	-	-

Power setting	Fuel flow, lb/hr	Thrust, lb	EGT, °F.	Emission index, lb/1000 lb of fuel			
				CO	CO_2	NO_X	Hydrocarbons
75%*	2155	2178	1058	28.38	-	5.67	0.636
90%*	2615	2655	1176	24.11	-	6.14	0.516
90%**	2655	2694	1196	23.73	-	6.16	0.482
Normal rated	2875	2893	1271	21.78	-	6.35	0.449
Military	2890	2905	1276	21.56	-	6.40	0.446

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour				Combustion efficiency, %	F/A
			CO	CO_2	NO_2	Hydrocarbons		
75%*	-	-	61.15	-	12.21	1.37	-	0.01508
90%*	-	-	63.05	-	16.05	1.35	-	0.01654
90%**	-	-	62.99	-	16.36	1.28	-	0.01667
Normal rated	-	-	62.62	-	18.25	1.29	-	0.01790
Military	-	-	62.32	-	18.50	1.29	-	0.01814

* Normal rated power ** Military power

NOTE: values in this table are taken from Naval Air Propulsion Test Center letter PE71:GES:ss, 10340 SER F973, of 24 April 1974.

TABLE LM15.1. GASEOUS EMISSIONS FROM A 7LM1500-PB-104A ENGINE
(SUMMARY OF FILES LM1501I, LM1501B, LM1501N, LM1501M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	124.1	0.43	1.6	-	41.5	-	20.09
75% Thrust	56.4	0.63	6.7	-	8.0	-	19.80
Normal rated	54.7	0.82	13.9	-	7.6	-	19.51
Intermediate	53.2	0.83	15.2	-	8.0	-	19.50

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	1237	565	5026	40.86	3336.90	1.32	10.36	12.02
75% Thrust	4597	6041	6957	4.14	3344.09	3.79	1.37	1.59
Normal rated	7903	10024	7453	2.26	3307.09	5.97	0.99	1.15
Intermediate	8356	10509	7564	1.82	3306.05	6.45	1.03	1.19

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	33	50.54	4127.74	1.63	14.87	98.02	0.001938
75% Thrust	-	104	19.02	15372.79	17.40	7.30	99.77	0.002832
Normal rated	-	172	17.87	26135.91	47.17	9.07	99.85	0.003725
Intermediate	-	186	15.25	27625.34	53.86	9.97	99.85	0.003771

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 13, Naval Air Rework Facility, North Island on 10 February 1975, single point probe, 50 feet behind the engine. Engine serial number 417214.

TABLE LM25.1. GASEOUS EMISSIONS FROM AN LM2500 ENGINE

(SUMMARY OF FILES LM2501I, LM2501B, LM2501C, LM2501D, LM2501E, LM2501F)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	259.1	0.65	2.3	-	334.8	-	19.77
7235 rpm	124.7	0.70	5.3	-	64.2	-	19.71
7708 rpm	64.6	0.82	10.3	-	16.7	-	19.53
7814 rpm	47.6	0.89	12.6	-	9.9	-	19.43
7949 rpm	26.9	0.97	17.3	-	5.2	-	19.31
8046 rpm	18.3	1.03	20.8	-	4.2	-	19.23

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	800	-	5000	77.73	3051.92	1.15	50.60	58.72
7235 rpm	1745	-	7235	36.51	3245.36	2.62	9.58	11.12
7708 rpm	2958	-	7708	15.96	3280.82	4.39	2.15	2.50
7814 rpm	3431	-	7814	10.65	3282.17	4.95	1.18	1.37
7949 rpm	4097	-	7949	5.23	3282.84	6.23	0.57	0.66
8046 rpm	4621	-	8046	3.14	3280.10	7.05	0.43	0.50

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	35	62.18	2441.54	0.92	46.97	93.14	0.003201
7235 rpm	-	76	63.72	5663.16	4.56	19.41	98.19	0.003242
7708 rpm	-	130	47.20	9704.67	12.98	7.39	99.41	0.003755
7814 rpm	-	148	36.52	11261.14	16.97	4.69	99.64	0.004072
7949 rpm	-	188	21.43	13449.79	25.54	2.70	99.82	0.004436
8046 rpm	-	215	14.52	15157.32	32.59	2.32	99.88	0.004714

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 20, Naval Air Rework Facility, North Island on 19 June 1977, single point probe, 95 feet behind the engine. Engine serial number GG018.

TABLE LM25.2. GASEOUS EMISSIONS FROM AN LM2500 ENGINE

(SUMMARY OF FILES LM2501G, LM2501H, LM2501J, LM2501K, LM2501L, LM2501N)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
8190 rpm	9.9	1.16	29.1	-	4.5	-	19.03
8210 rpm	9.3	1.17	29.8	-	4.1	-	19.02
8297 rpm	6.8	1.25	35.6	-	4.5	-	18.90
8415 rpm	5.1	1.33	45.4	-	5.6	-	18.78
8643 rpm	5.3	1.52	63.7	-	8.6	-	18.50
8752 rpm	4.5	1.58	73.0	-	6.9	-	18.41

Power setting	Fuel flow, lb/hr	Thrust, lb	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	$CH_{y/x}$	CH_4
8190 rpm	5647	-	8190	1.23	3271.41	8.74	0.41	0.48
8210 rpm	5710	-	8210	1.11	3270.93	8.87	0.37	0.4[illegible]
8297 rpm	6385	-	8297	0.60	3265.79	9.90	0.38	0.44
8415 rpm	7470	-	8415	0.28	3260.89	11.85	0.44	0.52
8643 rpm	9130	-	8643	0.25	3250.35	14.51	0.60	0.69
8752 rpm	10080	-	8752	0.13	3248.32	15.98	0.46	0.53

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
8190 rpm	-	270	6.95	18473.62	49.35	2.69	99.93	0.005320
8210 rpm	-	274	6.34	18677.01	50.66	2.45	99.94	0.005367
8297 rpm	-	309	3.85	20852.07	63.24	2.82	99.95	0.005741
8415 rpm	-	372	2.12	24358.85	88.55	3.85	99.95	0.006116
8643 rpm	-	461	2.28	29675.70	132.45	6.31	99.93	0.007008
8752 rpm	-	509	1.27	32743.01	161.12	5.38	99.95	0.007287

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 20, Naval Air Rework Facility, North Island on 19 June 1977, single point probe, 95 feet behind the engine. Engine serial number GG018.

TABLE T53.1. GASEOUS EMISSIONS FROM A T53-L-11D ENGINE
(SUMMARY OF FILES T53001I, T53001B, T53001N, T53001M, T53001T)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_X measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Ground idle	572.0	3.14	15.6	-	1856.9	-	16.01
Flight idle	542.0	2.60	19.8	-	344.6	-	16.79
Normal rated	186.0	3.79	71.5	-	20.4	-	15.12
Military	133.0	4.30	79.9	-	10.6	-	14.41
Takeoff	142.0	4.23	96.1	-	10.8	-	14.50

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, % rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Ground idle	145	35	42	31.51	2979.79	1.58	58.09	67.41
Flight idle	222	110	62	37.79	3119.75	2.53	13.57	15.75
Normal rated	645	410	95	6.83	3198.31	6.43	0.57	0.66
Military	685	569	98	3.34	3201.57	6.34	0.26	0.30
Takeoff	690	600	100	3.85	3201.13	7.75	0.27	0.32

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Ground idle	-	55	4.57	432.07	0.23	9.77	93.46	0.015705
Flight idle	-	83	8.39	692.58	0.56	3.50	97.77	0.012443
Normal rated	-	213	4.40	2062.91	4.15	0.43	99.78	0.017618
Military	-	211	2.29	2193.08	4.35	0.21	99.90	0.019933
Takeoff	-	258	2.66	2208.78	5.35	0.22	99.88	0.019616

Emissions measurements by the Aircraft Environmental Support Office at MCAS Camp Pendleton on 26 August 1975, single point probe at engine exhaust plane, engine on test stand. Engine serial number L-E 12771.

TABLE T56.1. GASEOUS EMISSIONS FROM A T56-A-16 ENGINE

(SUMMARY OF FILES T56001I, T56001B, T56001C, T56001D, T56001E, T56001M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry NO_X	Oxides of nitrogen measured, ppm, semi-dry NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
L/S Gr. idle	206.4	1.37	14.4	-	259.0	19.1	18.73
H/S Gr. idle	30.0	1.01	18.4	-	11.7	19.5	19.29
Flight idle	27.0	1.11	20.8	-	10.0	19.4	19.14
75%	8.2	2.07	59.7	-	3.3	18.0	17.72
100%	11.1	2.14	64.0	-	2.5	17.9	17.62
Military	11.1	2.21	67.1	-	2.9	17.6	17.51

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_X	$CH_{y/x}$	CH_4
L/S Gr. idle	599	130	9964	30.11	3149.25	3.53	19.24	22.32
H/S Gr. idle	756	245	13485	5.65	3275.53	6.35	1.22	1.42
Flight idle	836	510	13380	4.54	3268.50	6.52	0.95	1.10
75%	1996	3550	13820	0.42	3232.84	9.93	0.17	0.19
100%	2136	3890	13820	0.68	3230.89	10.29	0.12	0.14
Military	2219	4090	13820	0.65	3229.32	10.45	0.14	0.16

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm,		Emissions, pounds per hour				Combustion efficiency, %	F/A
	meas.	calc.	CO	CO_2	NO_2	CH_4		
L/S Gr. idle	120	116	18.04	1886.40	2.11	13.37	97.38	0.006523
H/S Gr. idle	196	198	4.27	2476.30	4.80	1.07	99.75	0.004629
Flight idle	207	205	3.80	2732.46	5.45	0.92	99.80	0.005096
75%	318	327	0.84	6452.74	19.82	0.39	99.97	0.009577
100%	330	340	1.45	6901.18	21.99	0.30	99.97	0.009904
Military	318	345	1.45	7165.85	23.18	0.35	99.97	0.010231

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 11, Naval Air Rework Facility, Alameda on 23 June 1976, single point probe. Engine serial number 102138.

TABLE T58.1. GASEOUS EMISSIONS FROM A T58-GE-8F ENGINE

(SUMMARY OF FILES T58A65I, T58A55B, T58A56C, T58A31D, T58A58N, T58A76M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, wet: NO_X	Oxides of nitrogen measured, ppm, wet: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	1100.9	1.02	5.2	-	1595.6	-	19.03
High idle	927.0	1.08	5.8	-	1008.5	-	18.96
Approach	153.2	1.79	22.7	-	19.1	-	18.01
Cruise	129.9	1.85	24.5	-	14.1	-	17.92
Max. cont.	125.9	1.95	27.0	-	13.6	-	17.77
Takeoff	96.4	2.12	32.7	-	8.0	-	17.53

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	132	15	15016	178.44	2569.31	1.43	130.42	151.34
High idle	149	27	16987	152.36	2760.33	1.62	83.67	97.09
Approach	581	918	24578	17.28	3210.80	4.47	1.12	1.30
Cruise	627	1027	24983	14.13	3214.97	4.68	0.80	0.93
Max. cont.	685	1159	25592	12.96	3214.12	4.90	0.73	0.85
Takeoff	786	1360	26689	9.03	3217.15	5.47	0.40	0.46

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	49	23.55	339.15	0.19	19.98	82.82	0.005961
High idle	-	53	22.70	411.29	0.24	14.47	88.10	0.005873
Approach	-	140	10.04	1865.47	2.60	0.75	99.49	0.008346
Cruise	-	147	8.86	2015.79	2.94	0.58	99.59	0.008613
Max. cont.	-	155	8.88	2201.67	3.36	0.58	99.63	0.009078
Takeoff	-	174	7.10	2528.68	4.30	0.36	99.75	0.009854

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 12, Naval Air Rework Facility, North Island on 6-7 June 1979, single point probe, 15 feet behind the engine. Engine serial number 271178.

TABLE T58.N1. GASEOUS EMISSIONS FROM A T58-GE-16 ENGINE (NAPC F991)

Power setting	Carbon monoxide measured, ppm	Carbon dioxide measured, %	Oxides of nitrogen NO_X measured, ppm	Oxides of nitrogen NO measured, ppm	Hydrocarbons measured, ppm	Oxygen meas., %	Oxygen calc., %
Ground idle	1125	1.41	15	13	641	-	-
60% Normal	155	2.07	51	50	8	-	-
75% Normal	124	2.22	66	63	14	-	-
90% Normal	109	2.32	73	70	20	-	-
90% Military	104	2.37	78	75	20	-	-
Military	98	2.45	89	86	33	-	-

Power setting	Fuel flow, lb/hr	Torque, ft-lb	EGT, °F.	Emission index, lb/1000 lb of fuel CO	CO_2	NO_X	Hydrocarbons
Ground idle	150	29	1059	139.73	-	3.03	40.91
60% Normal	656	284	1200	14.56	-	7.88	0.384
75% Normal	779	358	1301	10.89	-	9.47	0.628
90% Normal	890	431	1394	9.10	-	10.07	0.837
90% Military	924	453	1416	8.52	-	10.45	0.819
Military	1020	503	1482	7.73	-	11.60	1.32

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	Hydrocarbons	Combustion efficiency, %	F/A
Ground idle	-	-	20.96	-	0.454	6.14	-	-
60% Normal	-	-	9.55	-	5.17	0.252	-	-
75% Normal	-	-	8.48	-	7.37	0.489	-	-
90% Normal	-	-	8.10	-	8.96	0.745	-	-
90% Military	-	-	7.87	-	9.65	0.756	-	-
Military	-	-	7.89	-	11.84	1.35	-	-

NOTE: Emissions measurements by the Naval Air Propulsion Center, PE71:GES:ss, 10340, Ser F991, 13 June 1974.

TABLE T63.N1B. GASEOUS EMISSIONS FROM A T63-A-5A ENGINE (NAPTC)

Power setting	Carbon monoxide measured, ppm	Carbon dioxide measured, %	Oxides of nitrogen NO_x measured, ppm	Oxides of nitrogen NO measured, ppm	Hydrocarbons measured, ppm	Oxygen meas., %	Oxygen calc., %
Ground idle	825	1.96	-	9.0	423	-	-
Flight idle	645	2.00	-	12.0	218	-	-
30%	460	2.33	-	21.0	78	-	-
60%	308	2.93	-	37.0	20	-	-
75%	235	3.26	-	46.0	8	-	-
Military	145	3.83	-	61.0	3	-	-

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_x	Hydrocarbons
Ground idle	61	23.4	32850	79.15	-	1.420	20.30
Flight idle	70	23.7	36330	61.83	-	1.893	10.45
30%	105	96	42090	38.59	-	2.898	3.272
60%	157	218	47050	20.79	-	4.109	0.6752
75%	175	238	49220	14.31	-	4.608	0.2434
Military	215	305	52020	7.544	-	5.07	0.0781

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	Hydrocarbons	Combustion efficiency, %	F/A
Ground idle	-	-	4.828	-	0.0866	1.238	-	0.0105
Flight idle	-	-	4.328	-	0.1325	0.7314	-	0.0108
30%	-	-	4.052	-	0.3043	0.3436	-	0.0116
60%	-	-	3.264	-	0.6451	0.1060	-	0.0156
75%	-	-	2.504	-	0.8064	0.0426	-	0.0163
Military	-	-	1.622	-	1.09	0.0168	-	0.0188

NOTE: values in this table are taken from Naval Air Propulsion Test Center letter PE:GS:ss, 10340 SER 910, of 14 September 1972. Measurements of carbon monoxide, carbon dioxide and oxides of nitrogen are reported on a dry basis. JP-4 fuel.

TABLE T64.1. GASEOUS EMISSIONS FROM A T64-GE-6B ENGINE
(SUMMARY OF FILES T64001I, T64001B, T64001N, T64001M, T64001X)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry		Hydrocarbons measured, ppmC, wet	Oxygen	
			NO_X	NO		meas., %, semi-dry	calc., %, wet
Idle	417.2	1.39	11.5	-	182.0	-	18.66
75% hp	61.7	1.78	40.3	-	7.0	-	18.12
Normal rated	49.7	1.96	51.1	-	9.0	-	17.86
Military	43.7	2.05	58.4	-	10.0	-	17.73
Max. cont.	40.8	2.10	61.7	-	11.0	-	17.66

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	321	119	13459	57.27	3124.03	2.75	13.24	15.36
75% hp	1063	2052	16650	4.27	3234.24	7.80	0.41	0.48
Normal rated	1262	2679	17096	2.66	3231.12	8.97	0.48	0.56
Military	1370	3004	17544	1.87	3229.91	9.80	0.51	0.59
Max. cont.	1428	3167	17761	1.50	3229.15	10.11	0.55	0.64

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm,		Emissions, pounds per hour				Combustion efficiency, %	F/A
	meas.	calc.	CO	CO_2	NO_2	CH_4		
Idle	-	89	18.38	1002.81	0.88	4.93	97.35	0.006671
75% hp	-	253	4.54	3437.99	8.29	0.51	99.86	0.008240
Normal rated	-	293	3.35	4077.68	11.32	0.71	99.89	0.009076
Military	-	321	2.56	4424.98	13.43	0.81	99.91	0.009493
Max. cont.	-	331	2.14	4611.22	14.43	0.91	99.91	0.009726

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 9, Naval Air Rework Facility, North Island on 10 January 1974, single point probe, 40 feet behind the engine. Engine serial number 262265.

TABLE T64.31. GASEOUS EMISSIONS FROM A T64-GE-413 ENGINE
(SUMMARY OF FILES T64031I, T64031B, T64031N, To4031M, T64031X)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	380.5	1.37	10.8	-	234.7	-	18.71
75% hp	47.8	1.90	47.1	-	6.3	-	17.96
Normal rated	43.4	2.09	58.6	-	6.6	-	17.68
Intermediate	39.7	2.24	71.1	-	7.3	-	17.46
Maximum	38.4	2.31	76.7	-	5.9	-	17.36

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	260	64	11985	51.83	3120.68	2.62	17.28	20.05
75% hp	1287	2699	16875	1.94	3234.40	8.54	0.35	0.40
Normal rated	1511	3345	17274	1.20	3230.58	9.65	0.33	0.38
Intermediate	1661	3779	17472	0.67	3227.98	10.92	0.34	0.40
Maximum	1721	3937	17589	0.49	3227.08	11.42	0.27	0.31

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	86	13.48	811 38	0.68	5.21	97.07	0.006582
75% hp	-	279	2.50	4162.67	10.99	0.52	99.92	0.008791
Normal rated	-	317	1.81	4881.40	14.58	0.58	99.94	0.009675
Intermediate	-	360	1.12	5361.68	18.13	0.66	99.95	0.010373
Maximum	-	378	0.85	5553.80	19.65	0.54	99.96	0.010697

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 9, Naval Air Rework Facility, North Island on 28 January 1974, single point probe, 40 feet behind the engine. Engine serial number 2642[illegible].

TABLE T64.51. GASEOUS EMISSIONS FROM A T64-GE-415 ENGINE
(SUMMARY OF FILES T64051I, T64051B, T64051N, T64051M, T64051X)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	573.2	1.40	9.1	-	343.8	-	18.61
75%	75.2	2.51	59.2	-	3.2	-	17.03
Normal rated	70.7	2.72	73.7	-	2.0	-	16.73
Military	69.2	2.82	82.2	-	7.5	-	16.58
Max. rated	72.2	2.87	90.7	-	5.3	-	16.51

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel: CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	269	41	11755	74.33	3059.84	2.12	24.35	28.25
75%	1493	3066	17170	2.10	3221.31	8.09	0.13	0.16
Normal rated	1730	3660	17536	1.50	3219.21	9.29	0.08	0.09
Military	1916	4100	17750	1.29	3217.52	9.99	0.28	0.33
Max. rated	2005	4372	17910	1.47	3216.87	10.83	0.19	0.23

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour: CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Idle	-	69	20.00	823.10	0.57	7.60	95.84	0.006860
75%	-	266	3.14	4809.41	12.09	0.23	99.94	0.011636
Normal rated	-	307	2.60	5569.23	16.08	0.16	99.96	0.012609
Military	-	331	2.48	6164.77	19.15	0.62	99.94	0.013075
Max. rated	-	359	2.94	6449.83	21.72	0.45	99.95	0.013307

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 9, Naval Air Rework Facility, North Island on 23 October 1975, single point probe, 40 feet behind the engine. Engine serial number 264453.

TABLE T76.1. GASEOUS EMISSIONS FROM A T76-G-12A ENGINE
(SUMMARY OF FILES T76001I, T76001B, T76001M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry NO_x	Oxides of nitrogen measured, ppm, semi-dry NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Ground start	303.8	1.84	23.5	-	182.0	-	17.92
High idle	323.4	2.26	30.1	-	133.5	-	17.30
Military	95.6	4.23	88.9	-	1.9	-	14.50

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Ground start	180	-	40500	28.29	3162.13	4.30	10.21	11.85
High idle	212	-	40100	24.59	3170.73	4.50	6.13	7.12
Military	382	-	41700	1.69	3205.27	7.18	0.05	0.06

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	Oxides of nitrogen, corrected to 3% oxygen, ppm, calc.	Emissions, pounds per hour				Combustion efficiency, %	F/A
			CO	CO_2	NO_2	CH_4		
Ground start	-	136	5.09	569.18	0.77	2.13	98.32	0.008710
High idle	-	145	5.21	672.19	0.95	1.51	98.82	0.010654
Military	-	239	0.65	1224.41	2.74	0.02	99.96	0.019591

Emissions measurements by the Aircraft Environmental Support Office at MCAS Camp Pendleton on 26 August 1975, single point probe at engine exhaust plane, engine on test stand. Engine serial number 000427.

TABLE T400.1. GASEOUS EMISSIONS FROM A T400-CP-400 ENGINE
(SUMMARY OF FILES T40001I, T40001B, T40001C, T40001M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_X	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Ground idle	511.0	3.09	28.2	-	268.3	-	16.11
Flight idle	520.0	3.06	28.1	-	220.5	-	16.15
Cruise	108.0	3.75	53.8	-	5.4	-	15.20
Military	79.0	4.31	84.2	-	4.5	-	14.41

Power setting	Fuel flow, lb/hr	Torque ft-lb	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Ground idle	138	3	3366	29.78	3141.05	3.05	8.98	10.42
Flight idle	143	6	4105	30.71	3144.78	3.08	7.46	8.65
Cruise	283	20	5735	2.64	3206.59	4.90	0.15	0.18
Military	412	37	6310	0.75	3206.10	6.68	0.11	0.13

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	Oxides of nitrogen, corrected to 3% oxygen, ppm, calc.	Emissions, pounds per hour				Combustion efficiency, %	F/A
			CO	CO_2	NO_2	CH_4		
Ground idle	-	102	4.11	433.47	0.42	1.44	98.41	0.014662
Flight idle	-	102	4.39	449.70	0.44	1.24	98.54	0.014504
Cruise	-	163	0.75	907.46	1.39	0.05	99.92	0.017389
Military	-	223	0.31	1320.91	2.75	0.05	99.97	0.019951

Emissions measurements by the Aircraft Environmental Support Office at MCAS Camp Pendleton on 25 August 1975, single point probe at engine exhaust plane, engine on test stand. Engine seria number 64100.

TABLE GT.10. GASEOUS EMISSIONS FROM A GTC85-72 ENGINE
(SUMMARY OF FILES GT8501I, GT8501M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_X measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
No load	176.1	0.96	9.2	-	49.4	-	19.25
Load	157.6	2.14	24.3	-	2.7	-	17.51

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_X	$CH_{y/x}$	CH_4
No load	105	-	42400	37.43	3215.88	3.28	5.36	6.22
Load	210	-	42050	14.83	3208.28	3.88	0.13	0.15

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	Oxides of nitrogen, corrected to 3% oxygen, ppm, calc.	Emissions, pounds per hour				Combustion efficiency, %	F/A
			CO	CO_2	NO_2	CH_4		
No load	-	96	3.93	337.67	0.34	0.65	98.60	0.004482
Load	-	124	3.11	673.74	0.81	0.03	99.64	0.009974

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 103, Naval Air Rework Facility, Alameda on 29 July 1976, single point probe. Engine serial number 126P2245.

TABLE GT.20. GASEOUS EMISSIONS FROM A GTPC95-2 ENGINE
(SUMMARY OF FILES GT9501I, GT9501M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry: NO_x	Oxides of nitrogen measured, ppm, semi-dry: NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	86.7	0.94	11.9	-	19.3	-	19.37
100%	35.5	2.05	33.7	-	7.0	-	17.73

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_x	$CH_{y/x}$	CH_4
Idle	131	-	-	18.75	3259.21	4.39	2.16	2.50
100%	293	-	-	3.20	3228.29	5.65	0.36	0.42

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	Oxides of nitrogen, corrected to 3% oxygen, ppm, calc.	Emissions, pounds per hour				Combustion efficiency, %	F/A
			CO	CO_2	NO_2	CH_4		
Idle	-	135	2.46	426.96	0.58	0.33	99.35	0.004331
100%	-	185	0.94	945.89	1.66	0.12	99.89	0.009498

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 115, Naval Air Rework Facility, Alameda on 15 June 1976, single point probe. Engine serial number P-28735.

TABLE GT.30. GASEOUS EMISSIONS FROM A GTCP100-54 ENGINE
(SUMMARY OF FILES GT1001I, GT1001M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry		Hydrocarbons measured, ppmC, wet	Oxygen	
			NO_x	NO		meas., %, semi-dry	calc., %, wet
Idle	56.0	0.90	16.3	-	13.7	-	19.40
100%	52.3	1.72	29.7	-	2.7	-	18.19

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_x	$CH_{y/x}$	CH_4
Idle	225	-	35730	12.48	3276.38	6.32	1.61	1.87
100%	413	-	35190	5.89	3234.53	5.95	0.16	0.19

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm,		Emissions, pounds per hour				Combustion efficiency, %	F/A
	meas.	calc.	CO	CO_2	NO_2	CH_4		
Idle	-	188	2.81	737.19	1.42	0.42	99.55	0.004125
100%	-	190	2.43	1335.86	2.46	0.08	99.85	0.007963

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 114, Naval Air Rework Facility, Alameda on 28 June 1976, single point probe. Engine serial number P9907.

TABLE 62T.1. GASEOUS EMISSIONS FROM A T-62T-27 ENGINE
(SUMMARY OF FILES T6201I, T6201M)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen measured, ppm, semi-dry NO_X	Oxides of nitrogen measured, ppm, semi-dry NO	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Idle	149.0	1.03	15.9	-	29.2	-	19.20
100%	344.2	1.62	19.0	-	123.2	-	18.30

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, rpm	Emission index, lb/1000 lb of fuel				
				CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Idle	50	-	4330	29.53	3228.98	5.31	2.96	3.43
100%	102	100	4240	42.77	3154.46	3.94	7.79	9.04

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm,		Emissions, pounds per hour				Combustion efficiency, %	F/A
	meas.	calc.	CO	CO_2	NO_2	CH_4		
Idle	-	161	1.48	161.45	0.27	0.17	99.02	0.004788
100%	-	127	4.36	321.76	0.40	0.92	98.23	0.007693

Emissions measurements by the Aircraft Environmental Support Office at Test Cell 116, Naval Air Rework Facility, Alameda on 28 June 1976, single point probe.
Engine serial number S-424421.

TABLE WR27.1. GASEOUS EMISSIONS FROM A WR27-1 ENGINE
(SUMMARY OF FILES WR2701B, WR2701C)

Power setting	Carbon monoxide measured, ppm, semi-dry	Carbon dioxide measured, %, semi-dry	Oxides of nitrogen NO_X measured, ppm, semi-dry	Oxides of nitrogen NO measured, ppm, semi-dry	Hydrocarbons measured, ppmC, wet	Oxygen meas., %, semi-dry	Oxygen calc., %, wet
Low flow	76.6	1.49	9.3	-	8.5	-	18.47
High flow	121.7	2.37	32.5	-	4.8	-	17.13

Power setting	Fuel flow, lb/hr	Shaft hp	Speed, % rpm	Emission index, lb/1000 lb of fuel CO	CO_2	NO_X	$CH_{y/x}$	CH_4
Low flow	140	85	103	3.48	3199.86	2.13	0.60	0.69
High flow	140	85	102	5.66	3171.54	4.63	0.21	0.24

Power setting	Oxides of nitrogen, corrected to 3% oxygen, ppm, meas.	calc.	Emissions, pounds per hour CO	CO_2	NO_2	CH_4	Combustion efficiency, %	F/A
Low flow	-	67	0.49	447.98	0.30	0.10	99.86	0.006974
High flow	-	150	0.79	444.02	0.65	0.03	99.85	0.011153

Emissions measurements by the Aircraft Environmental Support Office at APU Test Stand, Naval Air Station, North Island on 10 December 1975, single point probe, at engine exhaust plane, engine on test stand. Engine serial number 121.

8 SUMMARY

8.1 Conclusions

Either a matrix solution of simultaneous equations or a linear combustion equation, derived from the matrix solution, is satisfactory for the calculation of the emission indexes of carbon monoxide, carbon dioxide, oxides of nitrogen, and hydrocarbons in the exhaust from gas turbine engines.

Assuming contemporary instruments, adjustments for instrument interferences, the basis of measurement (wet, dry, or semi-dry), the humidity of the inlet air and NO_x converter efficiency are technically desirable, but cause only small changes in the values of the emission indexes.

8.2 Recommendations

The Aircraft Environmental Support Office recommends either the comprehensive matrix solution (as defined by Reference 1), or equation (3) (Figure 4-1 of paragraph 4.2 of this Handbook) as the best methods for the calculation of an emission index of a constituent z.

$$EI_z = \left(\frac{[z]}{[CO] + [CO_2] + [C_xH_y]}\right)\left(\frac{10^3 M_z}{M_C + \alpha M_H}\right)(1 + TX/m) \qquad (3)$$

where z is CO, CO_2, NO_x, or C_xH_y.

The best method for making a quick estimation of an emission index is by use of equation (2) (Figure 4-1 of Paragraph 4.2).

$$EI_z = \left(\frac{[z]}{[CO] + [CO_2] + [C_xH_y] - T}\right)\left(\frac{10^3 M_z}{M_C + \alpha M_H}\right) \qquad (2)$$

When using equation (2) make the adjustments for instrument interferences, basis of measurement, humidity and NO_x converter efficiency before substitution in the equation.

Use the comprehensive matrix solution whenever a computer, capable of efficient matrix solution, is available; otherwise use a small programmable calculator and equations (2) or (3).

When using either computer or calculator, arrange the program to give a print-out of the numbers entered and the results of the calculation. See Figures 4-3 and 4-4 of this Handbook for examples of print-outs.

8.3 Additional Information

The Aircraft Environmental Support Office is glad to furnish additional information about gaseous emissions from aircraft engines.

For those calculating emission indexes, we can copy our computer and calculator programs to your disk or tape. The computer programs need either a 3 1/2 or a 5 1/4-inch disk. The calculator programs need a 3 1/2 disk, a mini data cassette, or program cards. We will help you modify our programs to meet your specific needs.

Those needing additional information should contact:

Commanding Officer
Attn. Aircraft Environmental Support Office, Code 61001
Naval Aviation Depot
North Island
San Diego, California 92135-5112

Commercial (619) 545-2901, Autovon 735-2901, FAX (619) 545-2910

9. REFERENCES

1. Aerospace Information Report, AIR 1533, *Procedure for the Calculation of Basic Emission Parameters for Aircraft Engines*, Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale, PA 15096, April 30, 1982.

2. Publication No. AP-42, *Compilation of Air Pollutant Emission Factors*, U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, August 1977.

3. Code of Federal Regulations, Vol. 40, Section 87, (through Federal Register Vol. 38, No. 36, July 17, 1973).

4. Aerospace Recommended Practice, ARP 1256, *Procedure for the Continuous Sampling and Measurement of Gaseous Emissions from Aircraft Turbine Engines*, Society of Automotive Engineers Inc., October 1, 1971.

5. Aerospace Recommended Practice, ARP 1256A, *Procedure for the Continuous Sampling and Measurement of Gaseous Emissions from Aircraft Turbine Engines*, Society of Automotive Engineers Inc., June 25, 1980.

6. W. Mirsky, W. Pace, R. Ponsonby, J. A. Nicholls, and D. E. Geister, *Critical Assessment of Emissions from Aircraft Piston Engines*, Federal Aviation Administration Report No. FAA-RD-78-82, June 1979 (through Reference 7).

7. Aerospace Information Report, AIR 1534, *Procedure for the Continuous Sampling Measurement of Gaseous Emissions from Aircraft Piston Engines*, Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale PA 15096, April 1982.

8. D. A. Kilpatrick, *Calculation Methodology for Basic Engine Exhaust Gaseous Emissions Parameters*, National Gas Turbine Establishment, Pyestock Farnborough Hants, Memorandum 81002, February 1981.

9. A.S.H.A.E. Psychrometric Chart, American Society of Heating and Air-conditioning Engineers, 1955.

10. T. Baumeister, Editor, *Handbook for Mechanical Engineers*, Seventh Edition, McGraw-Hill, New York, 1967.

11. E. M. Shelton and C. L. Dickson, *Aviation Turbine Fuels, 1984*, National Institute for Petroleum and Energy Research, P. O. Box 2128, Bartlesville, Oklahoma 74005, NIPER-139 PPS 85/2, March 1985.

12. Aircraft Environmental Support Office, *Environmental Calculations, A Handbook for the Use of Small Programmable Calculators to Determine the Effect of Aircraft on the Environment*, Second Edition, AESO Report No. 8-86, May 1987.

13. A. F. Klarman and T. J. Zidzik, *F404-GE-400 Engine Exhaust Emission Test Results, Interim Report*, Naval Air Propulsion Center, NAPC-LR-81-10, 30 November 1981.

14. Data and analysis pages from Phase II, sent as enclosures to Project Letter CRC Project No. CA-41/56, *Phase I and Phase II of CRC/FAA Emission Measurement Cross Correlation Program*, Coordinating Research Council, 219 Perimeter Center Parkway, Atlanta, GA 30346, March 18, 1981.

15. Scott Environmental Technology, Inc., *Individual Engine Test and Model Summary Reports, Modification 6, Alameda Testing, USAF Contract No. F29601-75-C-0046*, Prepared For: Air Force Civil Engineering Center, Tyndall Air Force Base, Florida, October 20, 1976.

16. Aircraft Environmental Support Office, *Emissions of Nitrogen Oxides from the Testing of F404-GE-400 Engines at Naval Air Station Lemoore, California*, AESO Report No. 4-85, July 1985.

17. S. P. Seto, *Emissions Characteristics of F101DFE Engine 509003/4 at Ground Level, Cell 6*, General Electric Technical Memorandum 82-697, 4 January 1983.

18. Naval Air Propulsion Test Center, *NAVAIR Work Assignment No. NAPTC-384 - Small Turbine Engine Exhaust Gas Pollution Measurements; Report on J85-GE-2 Engine Test*, Letter PE71:GES:ss, 10340 Ser F973 of 24 April 1974.

APPENDIX A

Calculator Programs

A1. PROGRAM AIRAP (HP-41C/41CV/41CX)

A1.1 Description of Program AIRAP

Program AIRAP calculates:

(1) emission indexes of carbon monoxide, carbon dioxide, oxides of nitrogen, and hydrocarbons as mass units per 1000 mass units of fuel, for example, as pounds per 1000 pounds (or grams per kilogram) of fuel;

(2) the concentrations of the constituents of the exhaust, adjusted to a wet basis;

(3) the concentration of oxygen in the exhaust;

(4) the concentration of the oxides of nitrogen in the exhaust, adjusted to a concentration of 3% oxygen;

(5) the concentration of water in the exhaust;

(6) the fuel to air ratio;

(7) the combustion efficiency; and

(8) the emission rates for the formation of the constituents, in pounds (or kilograms) per hour, for a specified fuel flow rate.

Program AIRAP uses a group of equations to make calculations which are comparable to those made using the comprehensive matrix solution of ten combustion equations as explained in Reference A1. (See Paragraph A1.8) Program AIRAP uses a printer.

A1.2 Definitions

EI_z = the emission index of the constituent z in units of mass per 1000 units of mass of the fuel, i.e., pounds per 1000 pounds (or grams per kilogram) of fuel

$[z]$ = the mole fraction concentration of a constituent z in the exhaust, specifically the mole fraction concentration of carbon monoxide, carbon dioxide, oxides of nitrogen, nitric oxide, nitrogen dioxide, hydrocarbons, oxygen or water

$[z]_s$ = the mole fraction concentration where s is 'ms' for measured, 'w' for wet, 'sd' for semi-dry, 'd' for dry and 'c' for corrected

M_z = the molecular weight of the constituent, specifically: carbon monoxide (28.0104), carbon dioxide (44.0098), nitrogen dioxide (46.0055), $CH_{y/x}$ (14.027, when y/x = 2/1); or methane (16.043)

M_C	=	the atomic weight of carbon (12.011)
M_H	=	the atomic weight of hydrogen (1.008)
M_{AIR}	=	the molecular weight of air (28.965)
α	=	the hydrogen-carbon ratio of the fuel, about 2 for JP-4 and about 1.8 for JP-5
T	=	the mole fraction of carbon dioxide in the dry inlet air (0.00032)
X	=	the number of moles of dry air per mole of fuel in the initial air-fuel mixture
m, n	=	the molecular constants for carbon and hydrogen in the fuel C_mH_n
x, y	=	the molecular constants for carbon and hydrogen in the exhaust hydrocarbons C_mH_n; m is assumed equal to x and n to y
h	=	the humidity of inlet air as moles of water vapor per mole of dry inlet air
h_{sd}	=	the humidity of the exhaust sample after a dryer (used in semi-dry measurements)
F	=	the fuel flow rate in pounds (or kilograms) of fuel per hour
F/A	=	the fuel to air ratio
J	=	the pressure-broadening coefficient for the effect of oxygen on carbon dioxide
L	=	the interference coefficient for the effect of carbon dioxide on carbon monoxide
L'	=	the interference coefficient for the effect of carbon dioxide on the oxides of nitrogen
M	=	the interference coefficient for the effect of water on carbon monoxide
M'	=	the interference coefficient for the effect of water on the oxides of nitrogen
K	=	the ratio of wet concentration of a constituent to the completely dry concentration
K_{sd}	=	the ratio of the completely dry concentration of a constituent to the semi-dry concentration
S	=	the mole fraction of nitrogen plus argon in dry inlet air (0.7902)

X/m, Z = intermediate numbers needed for calculations

η = the efficiency of the converter for changing nitrogen dioxide into nitric oxide, expressed as the fraction of nitrogen dioxide converted

A1.3 Calculation of Emission Indexes

The program needs inputs of (a) the instrument interference coefficients, (b) the molecular constants for the fuel; (c) the humidity of the inlet air as moles of water vapor per mole of dry inlet air [or relative humidity, temperature (or dew point) and barometric pressure from which the program calculates the humidity of the inlet air]; (d) the concentrations of carbon monoxide, carbon dioxide, oxides of nitrogen, nitric oxide and hydrocarbons in the exhaust; and (e) the fuel flow rate. For convenience, the program accepts the concentrations in the units measured (ppm or %), and then converts them to the mole fraction concentrations.

For this program, the concentrations of carbon monoxide and carbon dioxide must be on the semi-dry basis, the concentration of hydrocarbons, wet and the concentration of the oxides of nitrogen either wet or semi-dry.

The user of the program makes the following operations:

(1) selects either a wet or a semi-dry basis for the measurement of the oxides of nitrogen;

(2) accepts the values of the instrument coefficients stored in registers 11 to 15 by the program, or changes them;

(3) accepts the values of $(1 + h_{sd})$ and the efficiency of the oxides of nitrogen converter stored in registers 01 and 02 by the program, or changes them;

(4) sets the molecular constants for carbon and hydrogen in the fuel;

(5) either enters a value for h, or lets the program calculate it from an an entry of the appropriate combination of the relative humididy, dew point, temperature and barometric pressure; and

(6) enters the concentrations of carbon monoxide, carbon dioxide, oxides of nitrogen, nitric oxide (if measured), hydrocarbons and fuel flow rate.

The program is complicated in that the concentration of oxygen is unknown and the concentrations of carbon dioxide and oxygen are interdependent. The program uses two iterations. It first determines approximate values for K, X/m, Z and the concentrations of oxygen and water. The

instrument interference coefficents and the concentrations of oxygen and water adjust the measured concentrations of carbon dioxide, carbon monoxide and the oxides of nitrogen. The adjusted measured concentrations determine new values for K, X/m, Z and the concentrations of oxygen and water, which again adjust the originally measured concentrations. The adjusted concentrations, on a wet basis, determine the emission indexes.

Figures A1 to A5 give examples of the calculations. Most of the equations used in these calculations are those derived by Reference A1. For correlation, this paragraph identifies these equations with the notation 'SAE AIR 1533', for Reference A1; and a number in parenthesis, for the number assigned to the equation by Reference A1. These equations use the data of the 'Sample Calculation' on pages 34 and 35 of Reference A1.

These data are as follows:

J	= 0.09	m	= 9.5	carbon monoxide	= 500 ppm, semi-dry
L	= -0.00013	n	= 19.0	carbon dioxide	= 2.00%, semi-dry
L'	= 0.14	h	= 0.008843	oxides of nitrogen	= 20 ppm, wet
M	= -0.00045	h_{sd}	= 0.00607	nitric oxide	= 9 ppm, wet
M'	= 0.28		= 0.95	hydrocarbons	= 225 ppm, wet

In addition, to show the capabilities of program AIRAP, one option uses relative humidity, ambient temperature and barometric pressure to calculate the value of h, and another option uses an arbitrary fuel flow rate to calculate the emission rates of the constituents.

A matrix solution of the combustion equations by the HP-41 calculator is possible but too slow for practical use. One of the steps, the inversion of the 10 x 10 matrix, takes about 19 minutes. Therefore, programs for this calculator use the derived algebraic equations.

CALCULATION OF K_{sd}

$K_{sd} = 1 + h_{sd}$ SAE AIR 1533 (52)

$= 1 + 0.00607 = 1.00607$

CALCULATION OF $[CO]_d$, $[CO_2]_d$ AND $[NO_2]_d$

(These examples use concentrations adjusted for instrument interferences)

$[z]_d = [z]_{sd} \times K_{sd}$ SAE AIR 1533 (53)

$[CO]_d = 0.0004946 \times 1.00607 = 0.0004976$

$[CO_2]_d = 0.02032 \times 1.00607 = 0.02044$

$[NO_2]_d = ([NO_x]_{sd} - [NO]_{sd}) \times K_{sd}$

$= (0.00002 - 0.000009) \times 1.00607 = 0.00001107$

(The calculation of $[NO_2]_d$ is needed only if $[NO_x]_{ms}$ is semi-dry.)

CALCULATION OF K

(oxides of nitrogen measured wet)

When x = m and y = n, the last term in the numerator of equation SAE AIR 1533 (55), $[2 + h][(y/2x) - (\alpha/2)][C_xH_y]_w$, is zero. The following example uses equation SAE AIR 1533 (55) without this term.

$$K = \frac{(2 + h) + (\alpha T/2 - h)(1 + [NO_2]_w - (2/x)[C_xH_y]_w)}{(2 + h)\left((\alpha/2)([CO]_d + [CO_2]_d) + 1\right) - (\alpha T/2 - h)(1 - [CO]_d)}$$ SAE AIR 1533 (55)

when $(\alpha/2)([CC]_d + [CO_2]_d) + 1) = (2/2)(0.0004976 + 0.02044) + 1 = 1.02094$

$$= \frac{2.008843 + [(2 \times 0.00032/2) - 0.008843]\ [1 + 0.00001172 - 2/9.5)(0.000225)]}{2.008843 \times 1.02094 - (2 \times 0.00032/2 - 0.008843)(1 - 0.0004976)}$$

$= 0.9713$

Figure A1-1. Calculation of K_{sd}, $[CO]_d$, $[CO_2]_d$, $[NO_2]_d$ and K

CALCULATION OF $[O_2]_w$

$$[O_2]_w = \left(\frac{[(1 - S)(X/m) - \alpha/4] \ ([CO]_w + [CO_2]_w + [C_xH_y]_w)}{(1 + TX/m)}\right)$$

$$- \tfrac{1}{2}[CO]_w - [CO_2]_w + (y/4x)[C_xH_y] - [NO_2]_w - \tfrac{1}{2}[NO]_w$$

SAE AIR 1533 (78)

$$= \frac{((1 - 0.7902) \times 48.43 - 2/4)(0.0004833 + 0.01986 + 0.000225)}{(1 + 0.00032 \times 48.43)}$$

$$- \ \tfrac{1}{2}(0.0004883) - 0.01986 + (19/38)(0.000225 - 0.00001172 - \tfrac{1}{2}(0.0000091)$$

$$= 0.01757$$

CALCULATION OF $[H_2O]$

$$[H_2O]_w = \left(\frac{(\alpha/2 + hX/m) \ ([CO]_w + [CO_2]_w + [C_xH_y]_w)}{1 + TX/m}\right) - (y/2x)[C_xH_y]_w$$

SAE AIR 1533 (77)

$$= \frac{(2/2 + 0.008843 \times 48.43)(0.0004833 + 0.01986 + 0.000225)}{1 + 0.00032 \times 48.43} - (19/19)(0.000225)$$

$$= 0.0287$$

CALCULATION OF $[O_2]_{sd}$

$$[O_2]_{sd} = [O_2]_d \ /K_{sd}$$ SAE AIR 1533 (53)

$$= 0.1809/1.00607 = 0.1798$$

CALCULATION OF $[CO_2]_{c/sd}$

$$[CO_2]_c = [CO_2]_{ms} \ (1 + J[O_2])$$ SAE AIR 1533 (18)

$$= 0.02 \ (1 + 0.09 \times 0.1798) = 0.02032$$

Figure A1-3. Calculation of $[O2]_w$, $[H_2O]$, $[O_2]_{sd}$, and $[CO_2]_{c/sd}$

CALCULATION OF $[CO]_{c/sd}$

$[CO]_c = [CO]_{ms} + L[CO_2] + M[H_2O]$ SAE AIR 1533 (13)

$[CO]_{c/sd} = [CO]_{ms} + L[CO_2] + M[H_2O]$

$= 0.0005 + (-0.00013 \times 0.02032) + (-0.00045 \times 0.00607) = 0.0004946$

CALCULATION OF $[NO_x]_c$

(Oxides of Nitrogen measured wet)

$[NO_x]_c = [NO_x]_{ms} \times (1 + L'[CO_2] + M'[H_2O])$ SAE AIR 1533 (14)

$= 0.00002 \times (1 + 0.14 \times 0.02032 + 0.28 \times 0.0287) = 0.00002023$

$[NO]_c = 0.000009 \times (1 + 0.14 \times 0.02032 + 0.28 \times 0.0287) = 0.0000091.$

$[NO_2]_c = \frac{1}{\eta} \times [NO_2]_c$ SAE AIR 1533 (20)

$= (1/0.95) \times (0.00002023 - 0.0000091) = 0.00001172.$

Then:

$[NO_x]_c = [NO_2]_c + [NO]_c = 0.00001172 + 0.0000091 = 0.00002082$

Note: When correcting $[NO_x]_{sd}$, use $[H_2O]$ as 0.00607.

CALCULATION OF EMISSION INDEX FOR CARBON MONOXIDE

$$EI_{CO} = \left(\frac{[CO]}{[CO] + [CO_2] + [C_xH_y]}\right)\left(\frac{10^3\, M_{CO}}{M_C + \alpha M_H}\right)(1 + TX/m)$$

SAE AIR 1533 (64)

$$= \frac{0.0004833}{(0.0004833 + 0.01986 + 0.000225)} \quad \frac{1000 \times 28.011}{12.011 + 2 \times 1.008} \times$$

$$(1 + 0.00032 \times 48.44)$$

$$= 47.65$$

Figure A1-4. Calculation of $[CO]_{c/sd}$, $[NO_x]_c$ and EI_{CO}

CALCULATION OF OXIDES OF NITROGEN AT 3% OXYGEN

$$[NO_x] \text{ at } 3\% \text{ oxygen} = [NO_x]_m \times \frac{\text{oxygen in air (\%)} - 3\%}{\text{oxygen in air (\%)} - \text{oxygen in sample (\%)}}$$

$$[NO_x] \text{ at } 3\% \text{ oxygen} = 20.8 \times \frac{20.948 - 3}{20.948 - 17.57} = 110.5 \text{ ppm}$$

CALCULATION OF FUEL TO AIR RATIO (F/A)

$$F/A = \left(\frac{1}{X/m}\right)\left(\frac{M_C + \alpha M_H}{M_{air}}\right) \qquad \text{SAE AIR 1533 (59)}$$

$$= \frac{1}{48.43}\left(\frac{12.011 + 2.016}{28.965}\right) = 0.009999$$

CALCULATION OF COMBUSTION EFFICIENCY

$$\text{Combustion efficiency} = [1.00 - 4.346\,(EI_{CO}/H_c) - EI_{C_xH_y}/1000] \times 100$$

SAE AIR 1533 (75)

$$= (1.00 - 4.346 \times 47.65/18370 - 11.11/1000) \times 100$$

$$= 99.78\%$$

where H_c is 18,730 Btu per pound.

Figure A1-5. Calculation of oxides of nitrogen at 3% oxygen, fuel to air ratio (F/A) and the combustion efficiency

A1.4 Description of Labels Used in Program AIRAP

LABEL	USE
A	Initiates the input of data when the concentration of the oxides of nitrogen is measured on a wet basis.
B	Initiates the input of data when the concentration of the oxides of nitrogen is measured on a semi-dry basis.
C	Starts the calculation with the input of m, n and h using the set of instrument coefficients most recently stored.
D	Starts the program with the printing of the instrument coefficients, the values of m, n and h most recently stored, and the assigned values of h_{sd} and the efficiency of the nitrogen dioxide to nitric oxide converter.
E	Starts the program with the input of the concentration of the constituents. Label E does not print the instrument coefficients, the variables m, n, h, h_{sd} and the efficiency of the nitrogen dioxide to nitric oxide converter. Use Label E to continue a series of calculations for the same engine at different power settings.
F	Sets all instrument coefficients at zero and starts the program with the input of m, n and h.
G	Prints values for the constant K, and the intermediate numbers Z and X/m.

A1.5 Instructions for using program AIRAP

KEYSTROKES	DISPLAY	REMARKS
MINIMUM SIZE 045		
XEQ AIRAP	KEY A OR B	Program AIRAP needs inputs of the concentrations of carbon monoxide and carbon dioxide measured semi-dry, of hydrocarbons measured wet, and of oxides of nitrogen measured either wet (label A) or semi-dry (label B). This example uses a wet measurement of the concentration of the oxides of nitrogen. Key in A.
A	SET 11-15	The program sets the instrument coefficients at J = -0.07, L = -0.00013, L' = 0.14, M = -0.00045, and M' = 0.28, and stores them in registers 11 to 15. To use different coefficients change the numbers in registers 11 to 15. For example, to change the value of J to 0.09, key in .09 then STO 11. To set all instrument coefficients to zero, key in label F. This label uses the function 'CL Σ' to clear registers 11 to 16, which are the ones normally assigned as statistical registers and which, in this program, store the instrument coefficients.
.09	.09	Key in STO 11.
STO 11	.0900	Label A (or label B) also sets the values of other variables. The user may wish to change some of these numbers. Either make changes in the program, or make changes by storing new values for the variables in the appropriate registers. See list on page A1-15. Key in R/S to continue.
R/S	M?	Key in the the molecular constant m for the fuel C_mH_n.
9.5	9.5	Key in R/S to continue.
R/S	N?	Key in the molecular constant n.
19	19	Key in R/S to continue.
R/S	HUMIDITY?	Key in the humidity of the inlet air. If it is not known, key in zero and use option 1 elsewhere in this program. This demonstration continues as if the humidity of the inlet air is known.

Instructions for using program AIRAP (continued)

KEYSTROKES	DISPLAY	REMARKS
.008843	.008843	Key in R/S to continue.
R/S	CO?	The first two lines of the print-out show the input values of the instrument coefficients in the order J L L' M M'. The third line shows the input values of m, n and the humidity of the inlet air. The fourth line shows the values assigned to the humidity of the gas sample (semi-dry) and the converter efficiency. Key in the concentration of carbon monoxide as ppm.
500	500	Key in R/S to continue.
R/S	CO2?	Key in the concentration of carbon dioxide as %.
2	2	Key in R/S to continue.
R/S	NOX?	Key in the concentration of oxides of nitrogen as ppm.
20	20	Key in R/S to continue.
R/S	NO?	Key in the concentration of nitric oxide as ppm. Or, if the concentration of nitric oxide was not measured, either make no entry or key in zero.
9	9	Key in R/S to continue. If there is no entry for the concentration of nitric oxide, 'key in R/S' sets the concentration of nitric oxide at 97% of the concentration of the oxides of nitrogen.
R/S	CXHY?	The print-out shows the inputs of the concentrations of carbon monoxide, carbon dioxide, oxides of nitrogen and nitric oxide. Key in the concentration of hydrocarbons as ppm.
225	225	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate if known, otherwise make no entry. See option 2. This

KEYSTROKES	DISPLAY	REMARKS
		demonstration uses a sample calculation from Reference A1 for which a fuel flow rate was not specified.
		Key in R/S to continue.
R/S	CO?	The first print-out shows the concentration of hydrocarbons. The program continues to run. The second print-out, after about 32 seconds, shows the emission indexes of the constituents; the concentrations of the constituents on a wet basis, corrected for instrument interferences; the concentration of oxygen in the exhaust (% wet); the concentration of oxides of nitrogen (ppm) adjusted to 3% oxygen; the concentration of water (%) in the exhaust; the fuel to air ratio and the combustion efficiency (%). Continue with another set of concentrations (the program is at label E) or select A, B, C, or D. Refer to Paragraph A1.4 for the use of each label. Key in C to restart the calculation using the instrument coefficients of the previous calculation.
C	M?	Key in the the molecular constant m for the fuel C_mH_n.
9.5	9.5	Key in R/S to continue.
R/S	N?	Key in the molecular constant n.
19	19	Key in R/S to continue.
R/S	HUMIDITY?	Assume an unknown humidity for the inlet air. Use option 1 to calculate it.

Option 1

		Key in zero.
0	0	Zero indicates that the humidity of the inlet air is not known. The program must calculate it. Key in R/S to continue.
R/S	RH?	Key in the relative humidity as percent. To use a dew point instead of a relative humidity, key in 100 for the relative humidity.

Instructions for using program AIRAP (continued)

KEYSTROKES	DISPLAY	REMARKS
30	30	Key in R/S to continue.
R/S	T?	Key in the temperature as degrees F.
75	75	Key in R/S to continue.
R/S	B?	Key in the barometric pressure as inches of mercury.
29.92	29.92	Key in R/S to continue.
R/S	CO?	The first two lines of print-out show the input values of the instrument coefficients. The third line shows the input values of m, n and the humidity of the inlet air as calculated from the relative humidity. The fourth line shows the values assigned to the humidity of the gas sample (semi-dry) and the converter efficiency. The fifth line shows the relative humidity, temperature and barometric pressure. Key in the concentrations of carbon monoxide, carbon dioxide, the oxides of nitrogen, nitric oxide and hydrocarbons as directed in the preceding paragraphs, then

Option 2

KEYSTROKES	DISPLAY	REMARKS
R/S	FUEL?	Key in a fuel flow rate. For this demonstration use an arbitrary fuel flow rate of 1000 pounds per hour.
1000	1000	Key in R/S to continue.
R/S	CO?	The next print-out shows the concentration of hydrocarbons and the fuel flow rate. The print-out continues as previously described adding the emissions of the constituents, in pounds per hour. Note that the print-out also gives the amount of sulfur dioxide calculated as if all of the sulfur content of the fuel (estimated at 0.02%) changed to sulfur dioxide. To use a different concentration of sulfur in the fuel, change the number in program step 32.

Instructions for using program AIRAP (concluded)

KEYSTROKES	DISPLAY	REMARKS
		Option 3
G	CO?	Label G prints the values of K, Z, and X/m used in the preceding calculation and returns the program to label E.

Some of the registers contain variables which the user may want to change before running the program. These are as follows.

Register	Program line	Variable
01	11	1.00607 $1 + h_{sd}$
02	13	97.95 This register contains two variables. The format is xx.yy where xx is the percent (97) of nitrogen oxide in the oxides of nitrogen, and yy is the percent (95) of nitrogen dioxide changed to nitrogen oxide by the converter.
11	15	-0.07 Instrument coefficient J
12	17	-0.00013 Instrument coefficient L
13	19	0.14 Instrument coefficient L'
14	21	-0.00045 Instrument coefficient M
15	23	0.28 Instrument coefficient M'
32	25	0.02 Percent sulfur in the fuel
39	27	0.00032 T, the mole fraction of carbon dioxide in dry inlet air

A1.6 Program Listing for AIRAP

```
01+LBL "AIRAP"
02 "KEY A OR B"
03 PROMPT
04+LBL A
05 SF 03
06 GTO 20
07+LBL B
08 CF 03
09+LBL 20
10 FIX 4
11 1.00607
12 STO 01
13 97.95
14 STO 02
15 -.07
16 STO 11
17 -.00013
18 STO 12
19 .14
20 STO 13
21 -.00045
22 STO 14
23 .28
24 STO 15
25 .02
26 STO 32
27 .00032
28 STO 39
29 GTO 11
30+LBL F
31 CLΣ
32 GTO C
33+LBL 11
34 "SET 11-15"
35 PROMPT
36+LBL C
37 FIX 1
38 "M?"
39 PROMPT
40 STO 07
41 STO Y
42 "N?"
43 PROMPT
44 STO 08
45 X<>Y
46 /
47 STO 06
48 2
49 STO 09
50 /
51 RCL 39
52 *
53 STO 00
54 "HUMIDITY?"
55 PROMPT
56+LBL 16
57 STO 03
58 ST+ 09
59 -
60 STO 10
61 RCL 09
62 2
63 X=Y?
64 GTO "RH"
65+LBL D
66 FIX 2
67 RCL 11
68 ACX
69 "  "
70 ACA
71 RCL 12
72 ACX
73 "  "
74 ACA
75 RCL 13
76 ACX
77 PRBUF
78 "          "
79 ACA
80 RCL 14
81 ACX
82 "  "
83 ACA
84 RCL 15
85 ACX
86 PRBUF
87 ADV
88 FIX 1
89 RCL 07
90 ACX
91 RCL 08
92 ACX
93 RCL 03
94 FIX 6
95 ACX
96 FIX 1
97 PRBUF
98 "        "
99 ACA
100 RCL 01
101 1
102 -
103 FIX 5
104 ACX
105 "  "
106 ACA
107 RCL 02
108 FRC
109 FIX 2
110 ACX
111 PRBUF
112 FC? 00
113 GTO E
114 ADV
115 FIX 0
116 RCL 36
117 ACX
118 "  "
119 ACA
120 RCL 37
121 ACX
122 " "
123 ACA
124 FIX 2
125 RCL 38
126 ACX
127 PRBUF
128 ADV
129 CF 00
130 GTO E
131+LBL "RH"
132 SF 00
133 "RH?"
134 PROMPT
135 STO 36
136 "T?"
137 PROMPT
138 STO 37
139 50
140 RCL 37
141 X<=Y?
142 GTO 17
143 75
144 X<>Y
145 X<=Y?
146 GTO 18
147 .031767
148 *
149 E↑X
150 .080455
151 GTO 19
152+LBL 17
153 .038251
154 *
155 E↑X
156 .053226
157 GTO 19
158+LBL 18
159 .035264
160 *
161 E↑X
162 .061928
163+LBL 19
164 *
165 RCL 36
166 1 E2
167 /
168 *
169 ENTER↑
170 "B?"
171 PROMPT
172 STO 38
173 X<>Y
174 -
175 /
176 PRBUF
177 ADV
178 RCL 00
179 X<>Y
180 GTO 16
181+LBL E
182 ADV
183 FIX 1
184 "CO?"
185 PROMPT
186 ACX
187 1 E6
188 /
189 STO 21
190 STO 41
191 "CO2?"
192 PROMPT
193 FIX 2
194 ACX
195 1 E2
196 /
197 STO 22
198 STO 42
199 FIX 1
200 "NOX?"
```

Program Listing for AIRAP (continued)

```
201 PROMPT
202 FIX 1
203 ACX
204 1 E6
205 /
206 STO 23
207 STO 43
208 .
209 "NO?"
210 PROMPT
211 X=0?
212 GTO 03
213 GTO 04
214♦LBL 03
215 RCL 23
216 1 E6
217 *
218 RCL 02
219 INT
220 1 E2
221 /
222 *
223♦LBL 04
224 ACX
225 1 E6
226 /
227 STO 24
228 STO 44
229 PRBUF
230 "CXHY?"
231 PROMPT
232 ACX
233 1 E6
234 /
235 STO 25
236 STO 16
237 .
238 "FUEL?"
239 PROMPT
240 STO 27
241 X=0?
242 GTO 14
243 "  FUEL ="
244 ACA
245 ACX
246♦LBL 14
247 PRBUF
248 ADV
249 XEQ 10
250 XEQ 05
251 XEQ 10
252 RCL 41
253 STO 21
254 RCL 42
255 STO 22
256 RCL 43
257 STO 23
258 RCL 44
259 STO 24
260 XEQ 05
261 XEQ 10
262 GTO 06
263♦LBL 10
264♦LBL "K"
265 RCL 21
266 RCL 01
267 *
268 STO 35
269 LASTX
270 RCL 22
271 *
272 STO 36
273 FS? 03
274 GTO 21
275 RCL 23
276 RCL 01
277 *
278 STO 37
279 LASTX
280 RCL 24
281 *
282 STO 38
283 -
284 STO 40
285♦LBL 21
286 RCL 35
287 RCL 36
288 +
289 RCL 06
290 2
291 /
292 *
293 1
294 +
295 STO 17
296 1
297 FC? 03
298 GTO 12
299 RCL 23
300 STO 30
301 RCL 24
302 STO 31
303 -
304 +
305♦LBL 12
306 RCL 25
307 2
308 *
309 RCL 07
310 /
311 -
312 RCL 10
313 *
314 RCL 09
315 +
316 STO 00
317 RCL 17
318 RCL 09
319 *
320 RCL 10
321 1
322 RCL 35
323 -
324 FS? 03
325 GTO 13
326 RCL 40
327 +
328♦LBL 13
329 *
330 -
331 RCL 00
332 X<>Y
333 /
334 STO 18
335 RCL 35
336 X<>Y
337 *
338 STO 28
339 RCL 36
340 LASTX
341 *
342 STO 29
343 FS? 03
344 GTO "Z"
345 RCL 37
346 LASTX
347 *
348 STO 30
349 RCL 38
350 LASTX
351 *
352 STO 31
353♦LBL "Z"
354 2
355 RCL 28
356 -
357 2
358 RCL 07
359 /
360 RCL 08
361 RCL 07
362 /
363 2
364 /
365 -
366 RCL 25
367 *
368 -
369 RCL 30
370 RCL 31
371 -
372 +
373 RCL 28
374 RCL 29
375 RCL 25
376 +
377 +
378 STO 05
379 /
380 STO 19
381 2
382 *
383 RCL 06
384 -
385 1
386 RCL 03
387 +
388 RCL 19
389 RCL 39
390 *
391 2
392 /
393 -
394 4
395 *
396 /
397 STO 20
398 RCL 39
399 *
400 1
```

Program Listing for AIRAP (continued)

```
401 +
402 STO 34
403♦LBL 22
404 RCL 20
405 .2098
406 *
407 RCL 06
408 4
409 /
410 -
411 RCL 05
412 *
413 RCL 34
414 /
415 RCL 28
416 2
417 /
418 -
419 RCL 29
420 -
421 RCL 06
422 4
423 /
424 RCL 25
425 *
426 +
427 RCL 30
428 RCL 31
429 -
430 -
431 RCL 31
432 2
433 /
434 -
435 STO 26
436 RCL 03
437 RCL 20
438 *
439 RCL 06
440 2
441 /
442 +
443 RCL 05
444 *
445 RCL 34
446 /
447 RCL 16
448 RCL 08
449 *
450 RCL 07
451 /
452 2
453 /
454 -
455 STO 33
456 RTN
457♦LBL 05
458 RCL 26
459 RCL 01
460 /
461 RCL 18
462 /
463 RCL 11
464 *
465 1
466 +
467 ST* 22
468 RCL 22
469 RCL 12
470 *
471 RCL 14
472 RCL 01
473 1
474 -
475 *
476 +
477 ST+ 21
478 RCL 22
479 RCL 13
480 *
481 RCL 15
482 FS? 03
483 GTO 07
484 GTO 08
485♦LBL 07
486 RCL 33
487 GTO 09
488♦LBL 08
489 RCL 01
490 1
491 -
492♦LBL 09
493 *
494 +
495 1
496 +
497 ST* 23
498 ST* 24
499 RTN
500♦LBL G
501 ADV
502 FIX 6
503 "K ="
504 RCL 18
505 XEQ 02
506 "Z ="
507 RCL 19
508 XEQ 02
509 RCL 20
510 "X/"
511 ACA
512 SF 13
513 "M ="
514 XEQ 02
515 CF 13
516 ADV
517 GTO E
518♦LBL 06
519 RCL 06
520 1.008
521 *
522 12.011
523 +
524 STO 04
525 RCL 30
526 RCL 31
527 -
528 RCL 02
529 FRC
530 /
531 ST+ 31
532 21
533 STO 00
534 "EI     "
535 ACA
536 FIX 2
537 ADV
538 "CO ="
539 RCL 28
540 28011
541 XEQ 01
542 "CO2 ="
543 RCL 29
544 44009.8
545 XEQ 01
546 "NOX ="
547 RCL 31
548 46005.5
549 XEQ 01
550 "CXHY, CHY/X"
551 12011
552 RCL 06
553 1008
554 *
555 +
556 RCL 25
557 STO 16
558 XEQ 01
559 "CXHY, CH4 ="
560 RCL 25
561 16043
562 XEQ 01
563 ADV
564 "CO WET ="
565 RCL 28
566 1 E6
567 *
568 FIX 1
569 XEQ 02
570 "CO2 WET ="
571 RCL 29
572 1 E2
573 *
574 FIX 3
575 XEQ 02
576 "NOX WET ="
577 RCL 31
578 1 E6
579 *
580 FIX 1
581 XEQ 02
582 "CXHY WET ="
583 RCL 16
584 1 E6
585 *
586 XEQ 02
587 ADV
588 "% OXYGEN, WET ="
589 FIX 2
590 RCL 26
591 1 E2
592 *
593 XEQ 02
594 RCL 31
595 1 E6
596 *
597 FIX 1
598 RCL Y
599 20.948
600 -
```

Program Listing for AIRAP (concluded)

```
CHS
17.948
X<>Y
/
RCL Y
*
FIX 0
"NOX AT 3% 02 ="
XEQ 02
RCL 33
1 E2
*
FIX 2
"WATER ="
ACA
ACX
"%"
ACA
ADV
FIX 6
"F/A = "
1
ENTER↑
RCL 20
/
RCL 04
*
28.965
/
XEQ 02
1
ENTER↑
RCL 21
18730
/
4.346
*
-
RCL 24
1000
/
-
1 E2
*
FIX 2
"COMB. EFF. = "
ACA
ACX
"%"
ACA
ADV
21
STO 00
ADV
RCL 27
X=0?
GTO E
FIX 2
"POUNDS PER HOUR"
ACA
ADV
1 E3
/
STO Y
"CO ="
XEQ 26
"CO2 ="
XEQ 26
"NO2 ="
XEQ 26
"CHY/X ="
XEQ 26
"CH4 ="
XEQ 26
RCL 27
RCL 32
.02
*
*
"SO2 ="
XEQ 02
GTO E
•LBL 01
ACA
*
RCL 04
/
RCL 05
/
RCL 34
*
ACX
STO IND 00
ISG 00
•LBL 00
ADV
RTN
•LBL 02
ACA
ACX
ADV
RTN
•LBL 26
RCL IND 00
*
XEQ 02
X<>Y
STO Y
ISG 00
•LBL 00
RTN
.END.
```

A1.7 Example of print-out from program AIRAP

Using
h = 0.008843

```
0.09  -1.30-04   0.14
      -4.50-04   0.28

9.5 19.0 0.008843
     0.00607   0.95

500.0 2.00 20.0 9.0
225.0

                   EI
             CO = 47.65
           CO2 = 3076.41
             NOX = 3.37
      CXHY, CHY/X 11.11
      CXHY, CH4 = 12.71

         CO WET = 483.3
        CO2 WET = 1.986
         NOX WET = 20.8
       CXHY WET = 225.0

  % OXYGEN, WET = 17.57
   NOX AT 3% O2 = 111
         WATER = 2.87%
         F/A =  0.009998
   COMB. EFF. =  97.78%
```

Option 1
combined with
Option 2

```
0.09  -1.30-04   0.14
      -4.50-04   0.28

9.5 19.0 0.008820
     0.00607   0.95

30   75  29.92

500.0 2.00 20.0 9.0
225.0  FUEL = 1000.0

                   EI
             CO = 47.65
           CO2 = 3076.41
             NOX = 3.37
      CXHY, CHY/X 11.11
      CXHY, CH4 = 12.70

         CO WET = 483.4
        CO2 WET = 1.986
         NOX WET = 20.8
       CXHY WET = 225.0

  % OXYGEN, WET = 17.57
   NOX AT 3% O2 = 111
         WATER = 2.87%
         F/A =  0.009998
   COMB. EFF. =  97.78%

        POUNDS PER HOUR
             CO = 47.65
           CO2 = 3076.41
             NO2 = 3.37
           CHY/X = 11.11
             CH4 = 12.70
             SO2 = 0.40
```

Option 3

```
   K = 0.971317
   Z = 97.220045
X/A = 48.436237
```

Example of print-out from program AIRAP (concluded)

Content of the storage registers 00 to 44
after running program AIRAP using Options 1 and 2

R00= 26.000000	R12= -0.000130	R23= 3.368495	R34= 1.015500
R01= 1.006070	R13= 0.140000	R24= 11.108414	R35= 0.000498
R02= 97.950000	R14= -0.000450	R25= 12.704947	R36= 0.020447
R03= 0.008820	R15= 0.280000	R26= 0.175696	R37= 75.000000
R04= 14.027000	R16= 0.000225	R27= 1,000.000000	R38= 29.920000
R05= 0.020569	R17= 1.020945	R28= 0.000483	R39= 0.000320
R06= 2.000000	R18= 0.971317	R29= 0.019861	R40= 0.000000
R07= 9.500000	R19= 97.220045	R30= 0.000020	R41= 0.000500
R08= 19.000000	R20= 48.436237	R31= 0.000021	R42= 0.020000
R09= 2.008820	R21= 47.654044	R32= 0.020000	R43= 0.000020
R10= -0.008500	R22= 3,076.411406	R33= 0.028683	R44= 0.000009
R11= 0.090000			

A1.8 Reference

A1. Aerospace Information Report, AIR 1533, "Procedure for the Calculation of Basic Emission Parameters for Aircraft Engines," Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale, PA 15096, April 30, 1982.

A2. PROGRAM AIRA (HP-41C/41CV/41CX)

A2.1 Description of Program AIRA

Program AIRA makes the same calculations as program AIRAP. Program AIRAP needs a printer, program AIRA does not.

A2.2 Definitions

Program AIRA uses the same definitions as program AIRAP.

A2.3 Calculation of Emission Indexes

Program AIRA uses the same formulas as program AIRAP.

A2.4 Description of Labels Used in Program AIRA

Program AIRA does not use Label D. Otherwise, the use of the labels is the same as in Program AIRAP.

A2.5 Instructions for Using Program AIRA

KEYSTROKES	DISPLAY	REMARKS
MINIMUM SIZE 045		
XEQ AIRA	KEY A OR B	Follow the instructions for AIRAP. Use option 1 (page A1-13) and enter relative humidity, temperature and barometric pressure. After entering the concentrations of the constituents, use option 2 (page A1-14) and a fuel flow rate of 1000 pounds per hour.
1000	1000	Key in R/S to continue.
R/S	EI CO =	Key in R/S to continue.
R/S	47.65	The display shows the emission index for carbon monoxide. Key in R/S to continue.
R/S	EI CO2 =	Key in R/S to continue.
R/S	3076.41	The display shows the emission index for carbon dioxide. Key in R/S to continue.
R/S	EI NOX =	Key in R/S to continue.
R/S	3.37	The display shows the emission index for the oxides of nitrogen as nitrogen dioxide. Key in R/S to continue.
R/S	EI CHY/X =	Key in R/S to continue.
R/S	11.11	The display shows the emission index for hydrocarbons as $CH_{y/x}$. Key in R/S to continue.
R/S	EI CH4 =	Key in R/S to continue.
R/S	12.70	The display shows the emission index for hydrocarbons as methane. Key in R/S to continue.
R/S	CO WET =	Key in R/S to continue.
R/S	483.4	The display shows the concentration of carbon monoxide (ppm, wet). Key in R/S to continue.
R/S	CO2 WET =	Key in R/S to continue.

Instructions for Using Program AIRA (continued)

KEYSTROKES	DISPLAY	REMARKS
R/S	1.986	The display shows concentration of carbon dioxide (%, wet). Key in R/S to continue.
R/S	NOX WET =	Key in R/S to continue.
R/S	20.8	The display shows the concentration of the oxides of nitrogen (ppm, wet). Key in R/S to continue.
R/S	CXHY WET =	Key in R/S to continue.
R/S	225.0	The display shows the concentration of hydrocarbons (ppm, wet). Key in R/S to continue.
R/S	% OXYGEN WET =	Key in R/S to continue.
R/S	17.57	The display shows the concentration of oxygen (% wet). Key in R/S to continue.
R/S	NOX AT 3% O2=	Key in R/ S to continue.
R/S	110.5	The display shows the concentration of the oxides of nitrogen (ppm, wet) at a concentration of 3% oxygen. Key in R/S to continue.
R/S	% WATER =	Key in R/S to continue.
R/S	2.87	The display shows the concentration of water (%). Key in R/S to continue.
R/S	F/A =	Key in R/S to continue.
R/S	0.009998	The display shows the fuel to air ratio. Key in R/S to continue.
R/S	COMB. EFF.	Key in R/S to continue.
R/S	97.78	The display shows the combustion efficiency (%). Key in R/S to continue.
R/S	LBS CO =	Key in R/S to continue.
R/S	47.65	The display shows the pounds of carbon monoxide per hour. Key in R/S to continue.
R/S	LBS CO2 =	Key in R/S to continue.

Instructions for Using Program AIRA (concluded)

KEYSTROKES	DISPLAY	REMARKS
R/S	3076.41	The display shows the pounds of carbon dioxide per hour. Key in R/S to continue.
R/S	LBS NOX =	Key in R/S to continue.
R/S	3.37	The display shows the pounds of oxides of nitrogen (as nitrogen dioxide) per hour. Key in R/S to continue.
R/S	LBS CHY/X =	Key in R/S to continue.
R/S	11.11	The display shows the pounds of hydrocarbons per hour (as $CH_{y/x}$). Key in R/S to continue.
R/S	LBS CH4 =	Key in R/S to continue.
R/S	12.70	The display shows the pounds of hydrocarbons per hour (as methane). Key in R/S to continue.
R/S	LBS SO2 =	Key in R/S to continue.
R/S	0.40	The display shows the pounds of sulfur dioxide per hour. Key in R/S to continue.
R/S	CO?	Execution of the program returns to label E.

Option 3

G	CO?	The display shows successively the values of K, Z, and X/m. Execution of the program returns to label E.

A2.6 Program Listing for AIRA

```
01♦LBL "AIRA"
02 "KEY A OR B"
03 PROMPT
04♦LBL A
05 SF 03
06 GTO 20
07♦LBL B
08 CF 03
09♦LBL 20
10 FIX 4
11 1.00607
12 STO 01
13 97.95
14 STO 02
15 -.07
16 STO 11
17 -.00013
18 STO 12
19 .14
20 STO 13
21 -.00045
22 STO 14
23 .28
24 STO 15
25 .02
26 STO 32
27 .00032
28 STO 39
29 GTO 11
30♦LBL F
31 CLΣ
32 GTO C
33♦LBL 11
34 "SET 11-15"
35 PROMPT
36♦LBL C
37 FIX 1
38 "M?"
39 PROMPT
40 STO 07
41 "N?"
42 PROMPT
43 STO 08
44 X<>Y
45 /
46 STO 06
47 2
48 STO 09
49 /
50 RCL 39
51 *
52 STO 00
53 "HUMIDITY?"
54 PROMPT
55♦LBL 16
56 STO 03
57 ST+ 09
58 -
59 STO 10
60 RCL 09
61 2
62 X=Y?
63 GTO "RH"
64 GTO E
65♦LBL "RH"
66 "RH?"
67 PROMPT
68 STO 36
69 "T?"
70 PROMPT
71 STO 37
72 50
73 RCL 37
74 X<=Y?
75 GTO 17
76 75
77 X<>Y
78 X<=Y?
79 GTO 18
80 .031767
81 *
82 E↑X
83 .080455
84 GTO 19
85♦LBL 17
86 .038251
87 *
88 E↑X
89 .053226
90 GTO 19
91♦LBL 18
92 .035264
93 *
94 E↑X
95 .061928
96♦LBL 19
97 *
98 RCL 36
99 1 E2
100 /
101 *
102 ENTER↑
103 "B?"
104 PROMPT
105 STO 38
106 X<>Y
107 -
108 /
109 RCL 00
110 X<>Y
111 GTO 16
112♦LBL E
113 FIX 1
114 "CO?"
115 PROMPT
116 1 E6
117 /
118 STO 21
119 STO 41
120 "CO2?"
121 PROMPT
122 FIX 2
123 1 E2
124 /
125 STO 22
126 STO 42
127 "NOX?"
128 PROMPT
129 FIX 1
130 1 E6
131 /
132 STO 23
133 STO 43
134 .
135 "NO?"
136 PROMPT
137 X=0?
138 GTO 03
139 GTO 04
140♦LBL 03
141 RCL 23
142 1 E6
143 *
144 RCL 02
145 INT
146 1 E2
147 /
148 *
149♦LBL 04
150 1 E6
151 /
152 STO 24
153 STO 44
154 "CXHY?"
155 PROMPT
156 1 E6
157 /
158 STO 25
159 STO 16
160 .
161 "FUEL?"
162 PROMPT
163 STO 27
164 XEQ 10
165 XEQ 05
166 XEQ 10
167 RCL 41
168 STO 21
169 RCL 42
170 STO 22
171 RCL 43
172 STO 23
173 RCL 44
174 STO 24
175 XEQ 05
176 XEQ 10
177 GTO 06
178♦LBL 10
179♦LBL "K"
180 RCL 21
181 RCL 01
182 *
183 STO 35
184 LASTX
185 RCL 22
186 *
187 STO 36
188 FS? 03
189 GTO 21
190 RCL 23
191 RCL 01
192 *
193 STO 37
194 LASTX
195 RCL 24
196 *
197 STO 38
198 -
199 STO 40
200♦LBL 21
201 RCL 35
202 RCL 36
203 +
204 RCL 06
```

```
205 2
206 /
207 *
208 1
209 +
210 STO 17
211 1
212 FC? 03
213 GTO 12
214 RCL 23
215 STO 30
216 RCL 24
217 STO 31
218 -
219 +
220♦LBL 12
221 RCL 25
222 2
223 *
224 RCL 17
225 /
226 -
227 RCL 10
228 *
229 RCL 09
230 +
231 STO 00
232 RCL 17
233 RCL 09
234 *
235 RCL 10
236 1
237 RCL 35
238 -
239 FS? 03
240 GTO 13
241 RCL 40
242 +
243♦LBL 13
244 *
245 -
246 RCL 00
247 X<>Y
248 /
249 STO 18
250 RCL 35
251 X<>Y
252 *
253 STO 28
254 RCL 36
255 LASTX
256 *
257 STO 29
258 FS? 03
259 GTO "Z"
260 RCL 37
261 LASTX
262 *
263 STO 30
264 RCL 38
265 LASTX
266 *
267 STO 31
268♦LBL "Z"
269 2
270 RCL 28
271 -
272 2
273 RCL 07
274 /
275 RCL 08
276 RCL 07
277 /
278 2
279 /
280 -
281 RCL 25
282 *
283 -
284 RCL 30
285 RCL 31
286 -
287 +
288 RCL 28
289 RCL 29
290 RCL 25
291 +
292 +
293 STO 05
294 /
295 STO 19
296 2
297 *
298 RCL 06
299 -
300 1
301 RCL 03
302 +
303 RCL 19
304 RCL 39
305 *
306 2
307 /
308 -
309 4
310 *
311 /
312 STO 20
313 RCL 39
314 *
315 1
316 +
317 STO 34
318♦LBL 22
319 RCL 20
320 .2098
321 *
322 RCL 06
323 4
324 /
325 -
326 RCL 05
327 *
328 RCL 34
329 /
330 RCL 28
331 2
332 /
333 -
334 RCL 29
335 -
336 RCL 06
337 4
338 /
339 RCL 25
340 *
341 +
342 RCL 30
343 RCL 31
344 -
345 -
346 RCL 31
347 2
348 /
349 -
350 STO 26
351 RCL 03
352 RCL 20
353 *
354 RCL 06
355 2
356 /
357 +
358 RCL 05
359 *
360 RCL 34
361 /
362 RCL 16
363 RCL 08
364 *
365 RCL 07
366 /
367 2
368 /
369 -
370 STO 33
371 RTN
372♦LBL 05
373 RCL 26
374 RCL 01
375 /
376 RCL 18
377 /
378 RCL 11
379 *
380 1
381 +
382 ST* 22
383 RCL 22
384 RCL 12
385 *
386 RCL 14
387 RCL 01
388 1
389 -
390 *
391 +
392 ST+ 21
393 RCL 22
394 RCL 13
395 *
396 RCL 15
397 FS? 03
398 GTO 07
399 GTO 08
400♦LBL 07
401 RCL 33
402 GTO 09
403♦LBL 08
404 RCL 01
405 1
406 -
407♦LBL 09
408 *
```

Program Listing for AIRA (concluded)

```
+
1
+
ST* 23
ST* 24
RTN
♦LBL G
FIX 6
"K ="
RCL 18
PROMPT
STOP
"Z ="
RCL 19
PROMPT
STOP
RCL 20
"X/M ="
PROMPT
STOP
GTO E
♦LBL 06
RCL 06
1.008
*
12.011
+
STO 04
RCL 30
RCL 31
-
RCL 02
FRC
/
ST+ 31
21
STO 00
FIX 2
"EI CO ="
RCL 28
28011
XEQ 01
"EI CO2 ="
RCL 29
44009.8
XEQ 01
"EI NOX ="
RCL 31
46005.5
XEQ 01
"EI CHY/X ="
12011
RCL 06
1008
*
+
RCL 25
STO 16
XEQ 01
"EI CH4 ="
RCL 25
16043
XEQ 01
"CO WET ="
RCL 28
1 E6
*
FIX 1
PROMPT
STOP
"CO2 WET ="
RCL 29
1 E2
*
FIX 3
PROMPT
STOP
"NOX WET ="
RCL 31
1 E6
*
FIX 1
PROMPT
STOP
"CXHY WET ="
RCL 16
1 E6
*
PROMPT
STOP
"% OXYGEN, WET ="
FIX 2
RCL 26
1 E2
*
PROMPT
STOP
RCL 31
1 E6
*
FIX 1
RCL Y
20.948
-
CHS
17.948
X<>Y
/
RCL Y
*
FIX 1
"NOX AT 3% 02 ="
PROMPT
STOP
RCL 33
1 E2
*
FIX 2
"% WATER ="
PROMPT
STOP
FIX 6
"F/A = "
1
ENTER↑
RCL 20
/
RCL 04
*
28.965
/
PROMPT
STOP
1
ENTER↑
RCL 21
18730
/
4.346
*
-
RCL 24
1000
/
-
1 E2
*
FIX 2
"COMB. EFF. = "
PROMPT
STOP
21
STO 00
RCL 27
X=0?
GTO E
FIX 2
1 E3
/
STO Y
"LBS CO ="
XEQ 26
"LBS CO2 ="
XEQ 26
"LBS NOX ="
XEQ 26
"LBS CHY/X ="
XEQ 26
"LBS CH4 ="
XEQ 26
RCL 27
RCL 32
.02
*
*
"LBS SO2 ="
PROMPT
STOP
FIX 2
GTO E
♦LBL 01
*
RCL 04
/
RCL 05
/
RCL 34
*
PROMPT
STOP
STO IND 00
ISG 00
♦LBL 00
RTN
♦LBL 26
RCL IND 00
*
PROMPT
STOP
X<>Y
STO Y
ISG 00
♦LBL 00
RTN
.END.
```

A3. PROGRAM AIRB (HP-41C/41CV/41CX)

A3.1 Description of Program AIRB

Program AIRB calculates the emission indexes of carbon monoxide, carbon dioxide, oxides of nitrogen and hydrocarbons as mass units per 1000 mass units of fuel, for example, as pounds per 1000 pounds (or grams per kilogram) of fuel. This program makes no adjustments for the basis of measurement (wet, dry or semi-dry), the humidity, or the instrument interference coefficients. This program is much simpler than programs AIRAP and AIRA, makes fewer calculations and runs much faster. Manual entry of the program into the calculator memory is feasible. The best use of this program is for making quick estimates of emission indexes. Program AIRB does not require a printer.

A3.2 Definitions

Program AIRB uses the same definitions as Program AIRAP.

A3.3 Calculation of Emission Indexes

Program AIRB requires inputs of the concentrations of carbon monoxide, carbon dioxide, oxides of nitrogen and hydrocarbons. It does not require an input of the concentration of nitric oxide. The input uses the concentrations of the constituents as parts per million or as percent. The program converts each concentration to the mole fraction concentration. Program AIRB calculates the emission indexes using the equation

$$EI_z = \left(\frac{[z]}{[CO] + [CO_2] + [C_xH_y] - T} \right) \left(\frac{10^3 M_z}{M_C + \alpha M_H} \right)$$

A3.4 Description of Labels Used in Program AIRB

LABEL	USE
A	Initiates the input of data and sets the atomic hydrogen-to-carbon ratio at 2 to simulate JP-4 fuel.
B	Initiates the input of data and sets the atomic hydrogen-to-carbon ratio at 1.8 to simulate JP-5 fuel.
C	Initiates the input of data and sets the atomic hydrogen-to-carbon ratio at number specified by the user.
J	Initiates the input of data for a calculation which uses the atomic hydrogen-to-carbon ratio of the preceding calculation.

A3.5 Instructions for Using Program AIRB

KEYSTROKES	DISPLAY	REMARKS
MINIMUM SIZE 007		
XEQ AIRB	ENTER DATA	This command starts the program at Label A which makes calculations using a hydrogen-to-carbon ratio of 2 (JP-4). For other hydrogen-to-carbon ratios key in label B or label C. Label B sets the hydrogen-to-carbon ratio at 1.8 (JP-5). Label C uses a ratio specified by the user. If you wish to use either label B or C, key in now. This example uses the same emissions data as program AIRAP/AIRA (i.e., carbon monoxide, 500 ppm, carbon dioxide 2.00%, oxides of nitrogen 20 ppm and hydrocarbons 225 ppm) with adjustments for instrument interferences, converter efficiency and basis of measurement. The adjusted data entries are 483.3 ppm, 1.986%, 20.8 ppm, and 225 ppm. Key in the concentration of carbon monoxide as ppm.
483.3	483.3	Key in R/S to continue.
R/S	4.83 -04	The display shows the mole fraction concentration of carbon monoxide. Key in the concentration of carbon dioxide as %.
1.986	1.986	Key in R/S to continue.
R/S	.02	The display shows the mole fraction concentration of carbon dioxide. Key in the concentration of the oxides of nitrogen as ppm.
20.8	20.8	Key in R/S to continue.
R/S	2.08 -05	The display shows the mole fraction concentration of the oxides of nitrogen. Key in the concentration of hydrocarbons as ppm.
225	225	Key in R/S to continue.
R/S	EI CO =	Key in R/S to continue.
R/S	47.66	The display shows the emission index for carbon monoxide. Key in R/S to continue.

Instructions for Using Program AIRB (concluded)

KEYSTROKES	DISPLAY	REMARKS
R/S	EI CO2 =	Key in R/S to continue.
R/S	3077.34	The display shows the emission index for carbon dioxide. Key in R/S to continue.
R/S	EI NOX =	Key in R/S to continue.
R/S	3.37	The display shows the emission index for the oxides of nitrogen (calculated as nitrogen dioxide). Key in R/S to continue.
R/S	EI CXHY =	Key in R/S to continue.
R/S	12.71	The display shows the emission index for hydrocarbons (calculated as methane). Key in R/S to continue.
R/S	Key A, B, C or J	Labels A or B restart the program using hydrogen-to-carbon ratios of 2 or 1.8. Label C restarts the program using the hydrogen-to-carbon ratio selected by the user. Label J repeats the program using the hydrogen to carbon ratio of the previous calculation.
A or B	ENTER DATA	Repeat preceding steps.
C	H/C RATIO ?	Key in any hydrogen to carbon ratio.
1.83	1.83	Key in R/S to continue.
R/S	ENTER DATA	Key in the concentration of carbon monoxide and continue using the procedure already described.
J	ENTER DATA	Key in the concentration of carbon monoxide and continue using the procedure already described.

A3.6 Program Listing for AIRB

```
01♦LBL "AIRB"
02♦LBL A
03 14.027
04 GTO 01
05♦LBL B
06 13.825
07 GTO 01
08♦LBL C
09 "H/C RATIO"
10 PROMPT
11 1.008
12 *
13 12.011
14 +
15 GTO 01
16♦LBL J
17 RCL 05
18♦LBL 01
19 FIX 2
20 STO 05
21 1
22 STO 00
23 "ENTER DATA"
24 PROMPT
25 1 E6
26 /
27 STO 01
28 STOP
29 1 E2
30 /
31 STO 02
32 .00032
33 -
34 STOP
35 1 E6
36 /
37 STO 03
38 STOP
39 1 E6
40 /
41 STO 04
42 X<>Y
43 RCL 01
44 X<>Y
45 RDN
46 +
47 +
48 RCL 05
49 *
50 STO 06
51 28010
52 XEQ 02
53 44009.8
54 XEQ 02
55 46005.5
56 XEQ 02
57 16043
58♦LBL 02
59 RCL IND 00
60 *
61 RCL 06
62 /
63 STO IND 00
64 ISG 00
65♦LBL 00
66 4
67 RCL 00
68 X<=Y?
69 RTN
70 "EI CO ="
71 PROMPT
72 RCL 01
73 STOP
74 "EI CO2"
75 PROMPT
76 RCL 02
77 STOP
78 "EI NOX ="
79 PROMPT
80 RCL 03
81 STOP
82 "EI CXHY ="
83 PROMPT
84 RCL 04
85 STOP
86 "A, B, C OR J"
87 PROMPT
88 RTN
89 END
```

A4. PROGRAM AIRNP (HP-41C/41CV/41CX)

A4.1 Description of Program AIRNP

Program AIRNP uses inputs of either (a) time of operation, thrust and fuel flow rate or (b) time of operation, fuel flow rate and emission index to calculate:

(1) the amount of fuel used, and the amount of a constituent z produced, by the operation of a gas turbine engine at any power setting for a specified time;

(2) the total amount of the constituent z produced by a group of power settings, such as those used in the testing of an engine;

(3) the fuel used by the group of power settings; and

(4) the amount of the constituent z produced for each pound of fuel used by the group of power settings.

This program uses a printer.

A4.2 Definitions

W_z = the pounds (kilograms) of a constituent z produced by operation at a power setting for a specified time

EI_z = the emission index of the constituent z in the engine exhaust in units of mass per 1000 units of mass of the fuel, i.e., pounds (kilograms) per 1000 pounds (kilograms) of fuel used

F = the amount of fuel used at the power setting in pounds (kilograms) per hour

hr = the time in hours at the engine power setting

z = a constituent of the engine exhaust, e.g., carbon monoxide, carbon dioxide, oxides of nitrogen or hydrocarbons

A4.3 Calculations

The emission index, the fuel flow rate and the length of time at an engine power setting determine the amount of a constituent in the engine exhaust. For any power setting,

$$W_z = EI_z \times F/1000 \times hr.$$

The addition of the amounts of the constituent from each power setting gives the total amount of the constituent produced by the operation of the engine at a group of power settings.

The calculations need an emission index for each power setting for each constituent. The emission indexes may be determined from (a) measured concentrations of the constituents, or (b) a plot of known emission indexes vs. thrusts. The plotting method allows the calculation of an emission index at a power setting for which there was no measurement of the concentration of the constituent.

The plotting method uses a group of emission indexes (calculated from the measured concentrations of the constituent in the exhaust) and the corresponding values of thrusts. To demonstrate this method, program AIRNP uses the following data*.

Power setting	Thrust pounds	Emission index
15%	1597	3.95
20%	2069	4.56
26%	2728	5.15
37%	3845	6.42
46%	4883	8.37
63%	6662	11.78
76%	8031	14.80
Maximum cont.	9201	18.71
94%	9957	21.38
IRP	10548	25.16

Analysis of these data, using the program CFIT from the Hewlett-Packard Advantage Pac showed that they best fit the exponential equation

$$y = ae^{bx},$$

where y = emission index and x = thrust in pounds.

The print-out from program CFIT using these data appears in Paragraph A4.7.

To use this equation, the program must contain the constants 'a' and 'b'. Label C of program AIRNP contains these constants as steps 44 and 42. The program reserves labels A and B for user-determined constants for other engines and constituents. Labels A and B appear in the program listing with a space in place of the engine type indicator and by 'a' and 'b' in place of the constants. The user may wish to add other local labels such as D, E, G, I, a, d, and e for other engines and constituents.

* A. F. Klarman and J. J. Zidzik, "F404-GE-400 Engine Exhaust Emission Test Results, Interim Report," Naval Air Propulsion Center, NAPC-LR-81-10, 30 November 1981.

To improve the fit of the data, the curve fitting procedure omits values of thrusts and emission indexes for the power settings of idle (EI = 1.16) and afterburner (EI = 9.22). These power settings use emission indexes determined by measurement of concentrations.

A4.4 Description of Labels Used in Program AIRNP

LABEL	USE
A	Reserved for engine type and constants as specified by the user.
B	Reserved for engine type and constants as specified by the user.
C	Uses inputs of either (a) time, thrust and fuel flow rate, or (b) time, fuel flow rate and emission index to calculate the emissions from an engine. The demonstration in Paragraph A4.5 uses program steps which define the constants and print-out as emissions of the oxides of nitrogen from an F404-GE-400 engine.
E	Uses inputs of times, fuel flow rates and emission indexes to calculate emissions of any constituent. The print-out describes the constituent as 'z'.
F	May be used instead of 'XEQ AIRNP' to start the program, when the program is positioned in the main memory of the calculator.
J	After entry of data for any number of power settings, use label J to print-out the total amount of the constituent produced and the fuel used by these power settings. Label J also prints-out the amount of the constituent formed for each pound of fuel used.
H	cancels the last entry.
a	Sets the print-out of the constituent at 'CO'.
b	Sets the print-out of the constituent at 'CXHY'.

A4.5 Instructions for Using Program AIRNP

KEYSTROKES	DISPLAY	REMARKS
MINIMUM SIZE 010		
XEQ AIRNP	KEY A/B/C/E	When using label C, the print-out always records 'NOX' unless changed by executing labels a or b at this time. Label a changes the print-out to 'CO', label b to 'CXHY'. Label C contains programmed entries for an F404 engine and constants for the plot (as an exponential equation) of the emission indexes of the oxides of nitrogen vs. thrust. See Paragraph A4.3 for details. Labels A and B contain dummy entries. The user can change data in labels A, B or C, add other local labels such as D, G, I, c, d or e, or number labels from 09 to 99. These labels use the same arrangement of program steps as labels A, B or C. The example in this demonstration uses a simulated engine test for an F404 engine with run times, thrusts, fuel flow rates and emission indexes, at power settings as follows:

	Minutes	Thrust	F	EI
Idle	5	-	996	1.16
89% rpm	5	5945	4850	-
IRP	10	10190	8514	-
Afterburner	3	-	29750	9.22

Key in C.

KEYSTROKES	DISPLAY	REMARKS
C	MINUTES?	The print-out shows that the emission calculations are for an F404 engine for the oxides of nitrogen. Key in the time of operation at idle.
5	5	Key in R/S to continue.
R/S	THRUST?	The data at this power setting does not include thrust. Key in R/S to skip to the input of fuel flow rate.
R/S	FUEL?	Key in the fuel flow rate.
996	996	Key in R/S to continue.

Instructions for Using Program AIRNP (continued)

KEYSTROKES	DISPLAY	REMARKS
R/S	EI?	The print-out shows the time of operation and fuel flow rate at idle. Key in the emission index.
1.16	1.16	Key in R/S to continue.
R/S	MINUTES?	The print-out continues with the emission index, the fuel used and the pounds of oxides of nitrogen (as nitrogen dioxide) formed. Key in the time at the next power setting (89% rpm).
5	5	Key in R/S to continue.
R/S	THRUST?	Key in thrust.
5945	5945	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate.
4850	4850	Key in R/S to continue.
R/S	MINUTES?	The first line of the print-out shows the time of operation, thrust and fuel flow rate at 89% rpm. The second line shows the emission index (as calculated from the plot of thrust vs. emission indexes), the fuel used, and the pounds of oxides of nitrogen produced. Key in the time at the next power setting (IRP).
10	10	Key in R/S to continue.
R/S	THRUST?	Key in thrust.
10190	10190	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate.
8514	8514	Key in R/S to continue.
R/S	MINUTES?	The print-out shows input-output data as previously described. Key in the time at the next power setting (afterburner).
3	3	Key in R/S to continue.

Instructions for Using Program AIRNP (continued)

KEYSTROKES	DISPLAY	REMARKS
R/S	THRUST?	Key in R/S to use the emission index, instead of the thrust, for this calculation.
R/S	FUEL?	Key in the fuel flow rate.
29750	29750	Key in R/S to continue.
R/S	EI?	Key in the emission index.
9.22	9.22	Key in R/S to continue.
R/S	MINUTES?	The print-out shows input-output data as previously described. There are no other power settings in this example. Key in J to continue.
J	KEY A/B/C/E	The print-out shows the pounds of oxides of nitrogen produced by the sequence of power settings (50.60), the pounds of fuel used in the test (3394), and the pounds of the oxides of nitrogen produced for each pound of fuel used (0.01491). Key in E.
E	MINUTES?	The program is ready to start a new calcuation. Label E makes calculations using time of operation, fuel flow rate and emission index. Label E does not print a header. Use for any constituent. Use the data of the preceding example and emission indexes of 9.85 for 89% rpm and 23.12 for IRP. Key in the time of operation at idle.
5	5	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate.
996	996	Key in R/S to continue.
R/S	EI?	The print-out shows the time of operation and fuel flow rate at idle. Key in the emission index.
1.16	1.16	Key in R/S to continue.
R/S	MINUTES?	The print-out continues with the emission index, the fuel used and the pounds of the constituent z formed. Key in the time at the next power setting (89% rpm).

Instructions for Using Program AIRNP (continued)

KEYSTROKES	DISPLAY	REMARKS
5	5	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate.
4850	4850	Key in R/S to continue.
R/S	EI?	The print-out shows the time of operation and the fuel flow rate at 89% rpm. Key in the emission index.
9.85	9.85	Key in R/S to continue.
R/S	MINUTES?	The print-out continues with the emission index, the fuel used and the pounds of the constituent z formed. Key in the time at the next power setting (IRP).
10	10	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate.
8514	8514	Key in R/S to continue.
R/S	EI?	Key in the emission index for IRP.
23.12	23.12	Key in R/S to continue.
R/S	MINUTES?	The print-out shows input-output data as previously described. Key in the time at the next power setting (afterburner), making an intentional error.
35	35	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate.
29750	29750	Key in R/S to continue.
R/S	EI?	Key in the emission index.
9.22	9.22	Key in R/S to continue.
R/S	MINUTES?	The print-out shows input-output data as previously described. These data can be corrected after the print-out and before the next entry of time of operation. Key in H.

Instructions for Using Program AIRNP (concluded)

KEYSTROKES	DISPLAY	REMARKS
F	MINUTES?	The print-out notes that the preceding entry has been deleted. Continue with the correct entries for this power setting. Key in 3.
3	3	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate at afterburner.
29750	29750	Key in R/S to continue.
R/S	EI?	Key in the emission index for afterburner.
9.22	9.22	Key in R/S to continue.
R/S	MINUTES?	The print-out shows the corrected calculation. There are no other power settings in this example. Key in J to continue.
J	KEY A/B/C/E	The print-out shows the pounds of the constituent z produced by the sequence of power settings (50.60), the pounds of fuel used in the test (3394), and the pounds of the constituent z produced for each pound of fuel used (0.01491). The program is ready to start a new calculation.

A4.6 Program Listing for AIRNP

```
01•LBL "AIRNP"
02•LBL F
03 "NOX"
04 ASTO 06
05 "CO"
06 ASTO 07
07 "CXHY"
08 ASTO 08
09 "Z"
10 ASTO 09
11 6
12 STO 05
13 CF [illegible]
14 CF [illegible]
15 GTO 01
16•LBL a
17 7
18 STO 05
19 GTO 01
20•LBL b
21 8
22 STO 05
23•LBL 01
24 CLA
25 "KEY A/B/C/E"
26 PROMPT
27•LBL A
28 "b"
29 STO 03
30 "a"
31 STO 02
32 " "
33 GTO 02
34•LBL B
35 "b"
36 STO 03
37 "a"
38 STO 02
39 " "
40 GTO 02
41•LBL C
42 .00020093
43 STO 03
44 2.98393
45 STO 02
46 "F404"
47 GTO 02
48•LBL E
49 SF 01
50 9
51 STO 05
52•LBL 02
53 .
54 STO 00
55 STO 01
56 FS? 01
57 GTO 03
58 ACA
59 "      "
60 ACA
61 ARCL IND 05
62 ACA
63 ADV
64•LBL 03
65 ADV
66 "MINUTES?"
67 CF 29
68 FIX 1
69 PROMPT
70 STO 04
71 ACX
72 FS? 01
73 GTO 05
74 .
75 "THRUST?"
76 PROMPT
77 X=0?
78 GTO 05
79 ACX
80 RCL 03
81 *
82 E↑X
83 RCL 02
84 *
85 GTO 06
86•LBL 05
87 SF 02
88 "      "
89 ACA
90•LBL 06
91 "FUEL?"
92 PROMPT
93 ACX
94 PRBUF
95 FS?C 02
96 GTO 07
97 FS? 01
98 GTO 07
99 GTO 08
100•LBL 07
101 "EI?"
102 PROMPT
103 X<>Y
104•LBL 08
105 X<>Y
106 FIX 2
107 ACX
108 RCL 04
109 60
110 /
111 STO Z
112 RCL T
113 *
114 FIX 1
115 ACX
116 ST+ 00
117 STO Z
118 FIX 2
119 X<>Y
120 FIX 2
121 1 E3
122 /
123 *
124 ACX
125 ADV
126 FIX 1
127 ST+ 01
128 GTO 03
129•LBL J
130 ADV
131 "LBS "
132 ARCL IND 05
133 ACA
134 CLA
135 "/TEST ="
136 ACA
137 RCL 01
138 FIX 2
139 ACX
140 ADV
141 ADV
142 "LBS FUEL/TEST ="
143 ACA
144 FIX 0
145 RCL 00
146 ACX
147 ADV
148 ADV
149 "LBS "
150 ARCL IND 05
151 ACA
152 CLA
153 "/LBS OF FUEL"
154 ACA
155 PRBUF
156 "USED IN TEST ="
157 ACA
158 FIX 5
159 /
160 ACX
161 ADV
162 ADV
163 GTO F
164•LBL H
165 ST- 01
166 RDN
167 ST- 00
168 94
169 ACCHR
170 " "
171 ACA
172 "ENTRY DELETED"
173 FIX 0
174 ACA
175 ADV
176 GTO 03
177 END
```

A4.7 Example of Print-out from Program AIRNP

LABEL C

```
        F404          NOX

5.0          996.0
          1.16 83.0 0.10

5.0 5945.0 4850.0
         9.85 404.2 3.98

10.0 10190.0 8514.0
      23.12 1419.0 32.81

3.0           29750.0
       9.22 1487.5 13.71


   LBS NOX/TEST = 50.60

   LBS FUEL/TEST = 3394

LBS NOX/LBS OF FUEL
  USED IN TEST = 0.01491
```

LABELS E AND H

```
5.0          996.0
          1.16 83.0 0.10

5.0          4850.0
         9.85 404.2 3.98

10.0          8514.0
      23.12 1419.0 32.81

35.0         29750.0
     9.22 17354.2 160.01

         ↑  ENTRY DELETED

3.0          29750.0
       9.22 1487.5 13.71


     LBS Z/TEST = 50.60

   LBS FUEL/TEST = 3394

LBS Z/LBS OF FUEL
  USED IN TEST = 0.01491
```

LABEL CFIT

```
                XROM "CFIT"
Σ+  CLΣ FIT
                3.95 ENTER↑
             1597.00  XEQ A
Σ+  CLΣ FIT
                4.56 ENTER↑
             2069.00  XEQ A
Σ+  CLΣ FIT
                5.15 ENTER↑
             2728.00  XEQ A
Σ+  CLΣ FIT
                6.42 ENTER↑
             3845.00  XEQ A
Σ+  CLΣ FIT
                8.37 ENTER↑
             4883.00  XEQ A
Σ+  CLΣ FIT
               11.78 ENTER↑
             6662.00  XEQ A
Σ+  CLΣ FIT
               14.80 ENTER↑
             8031.00  XEQ A
Σ+  CLΣ FIT
               18.71 ENTER↑
             9201.00  XEQ A
Σ+  CLΣ FIT
               21.38 ENTER↑
             9957.00  XEQ A
Σ+  CLΣ FIT
               25.16 ENTER↑
            10548.00  XEQ A
Σ+  CLΣ FIT
                      XEQ E
L EX LOG P 8
                      XEQ E
EXP
a=2.98392688
b=0.00020093
R↑2=0.99832741
```

A5. PROGRAM AIRN (HP-41C/41CV/41CX)

A5.1 Description of Program AIRN

Program AIRN makes the same calculations as program AIRNP. Program AIRN does not use a printer.

A5.2 Definitions

Program AIRN uses the same definitions as program AIRNP.

A5.3 Calculation of Emission Indexes

Program AIRN uses the same calculations as program AIRNP.

A5.4 Description of Labels Used in Program AIRN

LABEL	USE
C	Uses inputs of either (a) time, thrust and fuel flow rate or (b) time, fuel flow rate and emission index to calculate the emissions of any constituent for a single power setting. When using option (a), the program must contain constants for an equation which defines the relation between thrust and emission index.
E	Uses inputs of times, fuel flow rates and emission indexes to calculate emissions of any constituent.
F	May be used instead of 'XEQ AIRN' to start the program, when the program is positioned in the main memory of the calculator.
J	After entry of data for any number of power settings, use label J to determine the total amount of the constituent produced and the fuel used by these power settings, and the amount of the constituent formed for each pound of fuel used.
H	Cancels the last entry.

A5.5 Instructions for Using Program AIRN

KEYSTROKES	DISPLAY	REMARKS
MINIMUM SIZE 005		
XEQ AIRN	KEY C or E	Label C needs, as program steps 08 and 10, constants which define the plot of thrust vs. the emission index of the constituent.
		The example in this demonstration uses a simulated engine test for an F404 engine with run times, thrusts, fuel flow rates and emission indexes, at power settings as follows:

	Minutes	Thrust	F	EI
Idle	5	-	996	1.16
89% rpm	5	5945	4850	-
IRP	10	10190	8514	-
Afterburner	3	-	29750	9.22

KEYSTROKES	DISPLAY	REMARKS
		Key in C.
C	MINUTES?	Key in the time of operation at idle.
5	5	Key in R/S to continue.
R/S	THRUST?	The data at this power setting does not include thrust. Key in R/S to skip to the input of fuel flow rate.
R/S	FUEL?	Key in the fuel flow rate.
996	996	Key in R/S to continue.
R/S	EI?	Key in the emission index.
1.16	1.16	Key in R/S to continue.
R/S	MINUTES?	Key in the time at the next power setting (89% rpm).
5	5	Key in R/S to continue.
R/S	THRUST?	Key in thrust.
5945	5945	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate.

Instructions for Using Program AIRN (continued)

KEYSTROKES	DISPLAY	REMARKS
4850	4850	Key in R/S to continue.
R/S	MINUTES?	Key in the time at the next power setting (IRP).
10	10	Key in R/S to continue.
R/S	THRUST?	Key in thrust.
10190	10190	Key in R/S to continue.
R/S	FUEL?	Key in the fuel flow rate.
8514	8514	Key in R/S to continue.
R/S	MINUTES?	Key in the time at the next power setting (afterburner).
3	3	Key in R/S to continue.
R/S	THRUST?	Key in R/S to use the emission index, instead of the thrust, for the calculation.
R/S	FUEL?	Key in the fuel flow rate.
29750	29750	Key in R/S to continue.
R/S	EI?	Key in the emission index.
9.22	9.22	Key in R/S to continue.
R/S	MINUTES?	There are no other power settings in this calculation. Key in J to continue.
J	Z/TEST =	Key in R/S to continue.
R/S	50.60	The display shows the pounds of the constituent produced by the sequence of power settings. Key in R/S to continue.
R/S	FUEL/TEST =	Key in R/S to continue.
R/S	3394	The display shows the pounds of fuel used in the test. Key in R/S to continue.
R/S	Z/LB FUEL =	Key in R/S to continue.

Instructions for Using Program AIRN (concluded)

KEYSTROKES	DISPLAY	REMARKS
R/S	0.01491	The display shows pounds of the constituent produced for each pound of fuel used. Key in R/S to continue.
R/S	KEY C OR E	The program is ready to start a new calculation from a group of power settings. Label E makes calculations using time of operation, fuel flow rate and emission index. Label H corrects an entry.

APPENDIX B

Computer Programs

Appendix B contains four figures, the listings for the computer programs MATEI, SAMPFL and the listing for the file T56001M.

Figure B1 lists the 100 components of the comprehensive matrix using the data from the sample calculation of SAE AIR 1533. Figure B2 shows the matrix constant and the P vector. Figure B3 gives specific examples of some calculations using the P vector. Figure B4 shows the print-out from program MATEI using a Hewlett Packard LaserJet printer and the default font of the printer. The data in Figure B4 are the same as those in Figure 4-6 of Paragraph 4.5.1. However, the appearance differs because the printer used other fonts to prepare Figure 4-6. These figures are references for anyone installing the matrix program on a computer.

The instructions for using the computer programs appear as comment lines at the beginning of and throughout the program listings. Additional instructions appear on the computer monitor during the operation of the programs.

MATRIX A

0	1	0	0	0
1	9.5	0	0	-.00032
0	0	0	0	2
0	19	0	0	-.017686
0	2	0	2	1
1	0	2	1	-.428443
0	0	0	0	0
0	0	1	1	-1.5804
.0201214	-1	0	.0018	-.0201214
0	0	0	0	0
5.003035E-04	-.00013	0	0	-5.003035E-04
-1	0	0	0	0
.000225	0	0	0	0
0	-9.5	0	0	0
.00002	.0000028	0	0	.0000056
0	0	-.95	-1	0
9.000001E-06	1.26E-06	0	0	2.52E-06
0	0	0	-1	0
-1	1	0	1	1
1	1	1	1	0

The size of matrix is 10 x 10. Each row of the matrix uses two lines of print-out. Columns 1 to 5 of the matrix are on the first line of the print-out for the row. Columns 6 to 10 are on the second line.

Figure B1. Components of matrix A for the solution of the ten sumiltaneous combustion equations using the data of the sample calculation of SAE AIR 1533 and program MATEI.

MATRIX CONSTANT

9.5
19
0
0
0
0
0
0
0
0

P VECTOR

Symbol	Program MATEI	Reported in SAE AIR 1533
P_T	469.0321	469.03
P_1	9.314995	9.3150
P_2	363.601	363.60
P_3	82.40501	82.405
P_4	13.46352	13.464
P_5	0.2267105	0.2267
P_6	1.110885E-02	0.011109
P_7	5.489647E-03	0.005490
P_8	4.266954E-03	0.004267
X	460.1441	460.14

Figure B2. Matrix constant for the solution of the ten simultaneous combustion equations using the data for the sample calculation of SAE AIR 1533 and program MATEI, and the P vector from the matrix solution.

DATA

J	= 0.09	m	= 9.5	carbon monoxide	= 500 ppm, semi-dry		
L	= −0.00013	n	= 19.5	carbon dioxide	= 2.00%, semi-dry		
L'	= 0.14	h	= 0.008843	oxides of nitrogen	= 20 ppm, wet		
M	= −0.00045	h_{sd}	= 0.00607	nitric oxide	= 9 ppm, wet		
M'	= 0.28	η	= 0.95	hydrocarbons	= 225 ppm, wet		

$P_T = 469.0321$ $\quad P_4 = 13.46352$ $\quad P_5 = 0.22671$

$M_{CO} = 28.01$ $\quad M_C = 12.011$ $\quad M_H = 1.008$

CALCULATION OF THE CONCENTRATION OF CARBON MONOXIDE
[equations (A33), (30) and (A8) of SAE AIR 1533]

$$\text{CO, ppm (dry)} = [P_5/(P_T - P_4)] \times 10^6$$

$$= [0.226711/(469.0321 - 13.46352)] \times 10^6$$

$$= 497.6$$

$$\text{CO, ppm (semi-dry)} = ([CO]_d/h_{sd}) \times 10^6$$

$$= (0.0004976/1.00607) \times 10^6 = 494.6$$

$$\text{CO, ppm (wet)} = (P_5/P_T)(10^6)$$

$$= (0.226711/469.0321) \times 10^6 = 483.4$$

CALCULATION OF THE EMISSION INDEX OF CARBON MONOXIDE
[equation (45) of SAE AIR 1533]

$$EI_{CO} = (P_5/m)(10^3 M_{CO})/(M_C + (n/m)M_H)$$

$$= (0.226711/9.5)(28.011 \times 10^3)/14.027$$

$$= 47.65$$

Figure B3. Calculation of the dry, semi-dry and wet concentrations and the emission index of carbon monoxide using the P vector.

T56-A-16 MILITARY File T56001M

J = -0.07	T = 97°F	m = 13.0
L = -0.00010	RH = 15%	n = 23.4
L' = 0.14	B = 29.86 in. Hg	NOx c/e = 0.95
M = -0.00033	h = 0.008884	
M' = 0.28	h_{sd} = 0.00607	

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	11.1	sd	7.0	6.9	6.8	0.65
Carbon dioxide	%	2.21	sd	2.20	2.18	2.13	3229.31
Oxides of nitrogen	ppm	67.1	sd	67.9	67.5	66.1	10.45
Nitric oxide	ppm			65.8	65.4	64.0	10.12
Nitrogen dioxide	ppm			2.1	2.1	2.1	0.33
Hydrocarbons, CHy/x	ppmC	2.9	w	3.0	3.0	2.9	0.14
Hydrocarbons, methane							0.16
Oxygen	%	17.6	sd	18.01	17.90	17.51	
Nitrogen	%			79.79	79.30	77.58	
Water, calc.	%					2.77	
Sulfur dioxide, calc.							0.40

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 345
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 318

K = 0.9723
F/A = 0.010231
Combustion efficiency = 99.97%
Shaft horsepower = 4090
Engine speed = 13820 rpm
Engine exhaust temperature = 1970°F

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 2219 pounds per hour

Carbon monoxide	1.45
Carbon dioxide	7165.85
Oxides of nitrogen	23.18
Hydrocarbons, CHy/x	0.31
Hydrocarbons, methane	0.35
Sulfur dioxide	0.89

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 23 JUNE 1976
Engine S/N 102138
Test Cell 11, single point probe in test cell exhaust stack.
JP-5 fuel.

Figure B4. Print-out from program MATEI.

```
10 'Program Listing  -  MATEI
20 '
30 'AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE, SEPTEMBER 1987 (jak)
40 '
50 'This program uses measured concentrations of carbon monoxide, carbon
60 'dioxide, oxides of nitrogen and hydrocarbons; and fuel flow rates to
70 'calculate emission indexes, emission rates and other emission parameters.
80 '
90 'The program uses the comprehensive matrix solution of ten combustion
100 'equations as described in Aerospace Information Report, AIR 1533.
110 '(Reference 1, of AESO 1-87).
120 '
130 'The program uses either an IBM Proprinter or a Hewlett Packard LaserJet
140 'printer.  If some other printer is used, it may be necessary to modify the
150 'program to get the proper value field for the degree symbol.  The LaserJet
160 'printer adds horizontal and vertical rules, and bold letters to the print-
170 'out if the printer has the HP 92286T font cartridge.  For an example of
180 'a ruled print-out see Figure 4-3 of paragraph 4.5.1.  Without the
190 '92286T cartridge, the LaserJet printer uses the default font (courier)
200 'resident in the printer.  For an example of this print-out see Figure B4
210 'of Appendix B.
220 '
230 'To print double strike on the IBM Proprinter, delete 3350.
240 'To print the matrix and the matrix constant, delete 4210.
250 'To print the P vector, delete 4310.
260 '
270 'To use this program your computer needs a basic compiler.  This program
280 'was written using the IBM Personal Computer Basic Version D3.10.
290 '
300 'To run this program, load the program and key in run.  Then, respond to
310 'queries as they appear on the monitor.
320 '
330 'The query "which file" has optional responses.
340 '
350 '(1) Key in the code of a file which you have established using the program
360 'SAMPFL. Key return to continue.
370 '
380 '(2) Key in 0 (zero) then return to permit entry of each variable in
390 'response to a series of queries.  If you respond to a query by keying
400 'return, the program makes no entry or for some variables assigns a default
410 'value.  Return sends the program to the next variable or continues the
420 'program if there are no other variables to be entered.  The variables
430 'assigned default values are PRI=2, SULF = 0.02%, m = 13, n = 23.4,
440 'hsd = 0.00607 and converter efficiency = 0.95.
450 '
460 'The variable h must have a value.  If it is assigned zero, the program
470 'next asks for inputs of relative humidity, temperature and barometric
480 'pressure.  After entry of the engine exhaust temperature (EGT), the pro-
490 'gram continues with the matrix calculation without further prompting.
500 '
510 '(3) Key in 9, then return to use the basic matrix of Reference 1, page 9.
520 'The basic matrix solution makes no adjustments for the basis of measure-
530 'ment, (wet, dry or semi-dry), humidity, instrument interferences or
540 'efficiency of the oxides of nitrogen converter.  This option uses the
```

```
550 'm and n values of JP-5 fuel.  If you want to use other values you
560 'must make changes in the program.
570 '
580 'The inputs using option (3) are the concentrations of carbon monoxide,
590 'carbon dioxide, oxides of nitrogen and hydrocarbons; and the fuel flow
600 'rate.  The calculations appear on the monitor as a table of emission
610 'indexes and emission rates.  This option is suitable for approximate
620 'calculations.
630 '
640 'For color monitors set foreground (FG) and background (BG) (line 680)
650 'to whatever color you wish.  FG must not be zero.  For monochrome
660 'monitors, BG must be zero.
670 '
680 FG=14:BG=1
690 '
700 OPTION BASE 1:COLOR FG,0:CLS
710 DIM A(10,10),E(10),F(10),G(10,10),P(10)
720 J$="####.#":K$="######.##":L$="####.###":N$="####.##"
730 '
740 FOR I = 1 TO 10:READ F(I):NEXT I
750 FOR I=1 TO 10:FOR J=1 TO 10:READ A(I,J):NEXT J:NEXT I
760 DATA 13,23.4,0,0,0,0,0,0,0,0
770 DATA 0,1,0,0,0,1,13,0,0,-0.00032
780 DATA 0,0,0,0,2,0,23.4,0,0,-.02
790 DATA 0,2,0,2,1,1,0,2,1,-0.4296
800 DATA 0,0,2,0,0,0,0,1,1,-1.5804
810 DATA 0,-1,0,0,0,0,0,0,0,0
820 DATA 0,0,0,0,0,-1,0,0,0,0
830 DATA 0,0,0,0,0,0,-13,0,0,0
840 DATA 0,0,0,0,0,0,0,-1,-1,0
850 DATA 0,0,0,0,0,0,0,0,-1,0
860 DATA -1,1,1,1,1,1,1,1,1,0
870 PRINT "KEY 1 FOR IBM PROPRINTER"
880 PRINT "KEY ENTER FOR HP LASERJET PRINTER"
890 PRINT
900 COLOR FG,BG:INPUT "WHICH PRINTER";PRI
910 IF PRI=0 THEN PRI=2
920 IF PRI=1 THEN 960 ELSE 930
930 LPRINT CHR$(27);"&a0R"
940 LPRINT  CHR$(27);"&a8L"
950 LPRINT  CHR$(27);"&k12H"
960 COLOR FG,0:CLS:COLOR FG,BG:INPUT "WHICH FILE";X$
970 IF X$="0" THEN 1020 ELSE 980
980 IF X$="9" THEN 990 ELSE 1900
990 C(1)=13:C(2)=23.4:C(3)=0:C(4)=0:C(5)=1:C(6)=2
1000 COLOR FG,0:CLS
1010 GOTO 1720
1020 PRINT:COLOR FG,0
1030 PRINT "FOR MEASUREMENTS BY AESO KEY IN 1"
1040 PRINT "FOR MEASUREMENTS BY NAPC KEY IN 2"
1050 PRINT "FOR MEASUREMENTS BY OTHERS  KEY NAME"
1060 PRINT:COLOR FG,BG
1070 INPUT "  MEASURED BY     ";M$
1080 IF M$="1" THEN 1110
1090 IF M$="2" THEN 1130
```

```
1100 GOTO 1140
1110 M$="AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE"
1120 GOTO 1140
1130 M$="NAVAL AIR PROPULSION CENTER"
1140 COLOR 12,0:PRINT TAB(15)M$
1150 COLOR FG,BG
1160 INPUT "  PLACE OF MEASUREMENT";P$:PRINT
1170 INPUT "  DATE OF MEASUREMENT";D$:PRINT
1180 INPUT "  ENGINE SERIAL NUMBER";SN$:PRINT
1190 INPUT "  ADDITIONAL REMARKS (LINE 1)";R$:PRINT
1200 INPUT "  ADDITIONAL REMARKS (LINE 2)";RR$:PRINT
1210 INPUT "  ENGINE TYPE, NUMERAL, MANF.,MODEL (EX. J79-GE-8)";A$:PRINT
1220 INPUT "  POWER SETTING";B$:PRINT
1230 COLOR FG,0:PRINT
1240 PRINT "1 STARTS WITH INPUT OF INSTRUMENT COEFFICIENTS"
1250 PRINT "2 STARTS WITH INPUT OF x, y, h"
1260 PRINT:COLOR FG,BG
1270 INPUT "  KEY IN 1, 2.";R:COLOR 14,0
1280 CLS:PRINT
1290 IF R=1 THEN 1350
1300 IF R=2 THEN 1410
1310 COLOR 2,0
1320 CLS:PRINT "YOU MUST KEY IN 1 OR 2 TO USE THE MATRIX":PRINT :PRINT
1330 GOTO 1230
1340 X=5:GOTO 1500
1350 COLOR FG,BG
1360 INPUT "J"; B(1):PRINT
1370 INPUT "L"; B(2):PRINT
1380 INPUT "L'"; B(3):PRINT
1390 INPUT "M"; B(4):PRINT
1400 INPUT "M'"; B(5):PRINT
1410 COLOR FG,0:PRINT
1420 PRINT "3 CONTINUES WITH INPUT OF x, y, h"
1430 PRINT "5 CONTINUES WITH INPUT OF x, y, h, hsd, converter efficiency"
1440 PRINT:COLOR FG,BG
1450 INPUT "  3, or 5"; X:COLOR FG,0
1460 CLS:PRINT
1470 PRINT
1480 IF X=3 THEN 1490
1490 COLOR FG,BG
1500 INPUT "x";C(1):PRINT
1510 IF C(1)=0 THEN C(1)=13
1520 INPUT "y";C(2):PRINT
1530 IF C(2)=0 THEN C(2)=23.4
1540 INPUT "h";C(3):C(4)=.00607:C(5)=.95:PRINT
1550 IF C(3)=0 THEN 1560 ELSE 1590
1560 INPUT "RELATIVE HUMIDITY";C(7):PRINT
1570 INPUT "TEMPERATURE";C(8):PRINT
1580 INPUT "BAROMETRIC PRESSURE";C(9):PRINT
1590 IF X=5 THEN 1600 ELSE 1640
1600 INPUT "hsd";C(4):PRINT
1610 IF C(4)=0 THEN C(4)=.00607
1620 INPUT "CONVERTER EFFICIENCY";C(5):PRINT
1630 IF C(5)=0 THEN C(5)=.95
1640 COLOR FG,0
```

```
1650 INPUT "SULFUR CONTENT OF FUEL, %";SULF:PRINT
1660 IF SULF=0 THEN SULF=.02:'%
1670 PRINT "KEY 1 FOR NOx MEASURED WET"
1680 PRINT "KEY 2 FOR NOx MEASURED SEMI-DRY"
1690 PRINT :COLOR FG,BG
1700 INPUT "  NOX MEASUREMENT";C(6):PRINT
1710 PRINT:COLOR FG,0:CLS:COLOR FG,BG
1720 IF X$="9" THEN 1730 ELSE 1740
1730 INPUT "  ENGINE TYPE, NUMERAL, MANF.,MODEL (EX. J79-GE-8)";A$:PRINT
1740 INPUT "  POWER SETTING";B$:PRINT
1750 INPUT " CO";D(1):PRINT
1760 INPUT " CO2";D(2):PRINT
1770 INPUT " NOx";D(3):PRINT
1780 IF X$="9" THEN 1800 ELSE 1790
1790 INPUT " NO";D(4):PRINT
1800 INPUT "CxHy";D(5):PRINT
1810 IF X$="9" THEN 1830 ELSE 1820
1820 INPUT "O2";D(6):PRINT
1830 INPUT "FUEL FLOW";FF:PRINT
1840 IF X$="9" THEN 1960 ELSE 1850
1850 INPUT "THRUST";TH:PRINT
1860 INPUT "HORSEPOWER";HP:PRINT
1870 INPUT "RPM";RPM:PRINT
1880 INPUT "EGT";EGT:PRINT
1890 GOTO 1960
1900 X$="A:"+X$
1910 OPEN "I",#1,X$
1920 INPUT #1,A$,B$,F$,M$,P$,D$,SN$,R$,RR$,FF,TH,RPM,HP,EGT,SULF
1930 INPUT #1,B(1),B(2),B(3),B(4),B(5)
1940 INPUT #1,C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9)
1950 INPUT #1,D(1),D(2),D(3),D(4),D(5),D(6)
1960 PRINT:COLOR 2,0:PRINT "WAIT"
1970 IF C(7)=0 THEN 1980
1980 IF C(8)=0 THEN 2120 ELSE 1990
1990 IF C(8)<51 THEN 2040 ELSE 2000
2000 IF C(8)<76 THEN 2070 ELSE 2010
2010 X=.031767*C(8)
2020 VP=EXP(X)*.080455
2030 GOTO 2100
2040 X=.038251*C(8)
2050 VP=EXP(X)*.053226
2060 GOTO 2100
2070 X=.035264*C(8)
2080 VP=EXP(X)*.061928
2090 GOTO 2100
2100 AVP=C(7)/100*VP
2110 C(3)=AVP/(C(9)-AVP)
2120 F(1)=C(1):F(2)=C(2)
2130 IF X$="9" THEN 2170
2140 IF D(4)=0 THEN 2150 ELSE 2170
2150 D(4)=D(3)*.97
2160 FLAG=1
2170 A(1,7)=C(1):A(2,7)=C(2)
2180 A(2,10)=(-2)*C(3):A(3,10)=-.41896-.00064-C(3)
2190 E=D(2)/100*(1+C(4))
```

```
2200 A(5,1)=E:A(5,4)=D(2)/100*B(1):A(5,5)=-E
2210 E=D(1)/10^6*(1+C(4))
2220 A(6,1)=E+C(4)*B(4):A(6,5)=-E-C(4)*B(4):A(6,2)=B(2)
2230 A(7,1)=D(5)/10^6:A(7,7)=-C(1)
2240 A(8,1)=D(3)/10^6:A(8,2)=D(3)/10^6*B(3)
2250 A(8,5)=D(3)/10^6*B(5):A(8,8)=-C(5)
2260 A(9,1)=D(4)/10^6:A(9,2)=D(4)/10^6*B(3)
2270 A(9,5)=D(4)/10^6*B(5)
2280 IF C(6)=1 THEN 2340
2290 Q=1+C(4)*(1+B(5))
2300 A(8,1)=D(3)/10^6*Q:A(8,5)=-A(8,1)
2310 A(9,1)=D(4)/10^6*Q:A(9,5)=-A(9,1)
2320 IF X$="9" THEN 2330 ELSE 2340
2330 A(6,5)=0: A(8,5)=0:A(5,5)=0
2340 FOR I=1 TO 10
2350 FOR J=1 TO 10
2360 G(I,J)=A(I,J)
2370 NEXT J:NEXT I
2380 FOR I=1 TO 10
2390 E(I)=F(I)
2400 NEXT I
2410 FOR J1=1 TO 10
2420 TEMP = 0
2430 FOR J2 = J1 TO 10
2440 IF ABS(A(J2,J1))<TEMP THEN GOTO 2470
2450 TEMP = ABS(A(J2,J1))
2460 IBIG = J2
2470 NEXT J2
2480 IF IBIG = J1 THEN GOTO 2570
2490 FOR J2 =J1 TO 10
2500 TEMP = A(J1,J2)
2510 A(J1,J2)=A(IBIG,J2)
2520 A(IBIG,J2)=TEMP
2530 NEXT J2
2540 TEMP = E(J1)
2550 E(J1)=E(IBIG)
2560 E(IBIG)=TEMP
2570 IF J1=10 THEN GOTO 2670
2580 N1 = J1+1
2590 FOR J2=N1 TO 10
2600 A(J2,J1)=A(J2,J1)/A(J1,J1)
2610 FOR J3=N1 TO 10
2620 A(J2,J3)=A(J2,J3)-A(J2,J1)*A(J1,J3)
2630 NEXT J3
2640 E(J2)=E(J2)-A(J2,J1)*E(J1)
2650 NEXT J2
2660 NEXT J1
2670 E(10)=E(10)/A(10,10)
2680 N1=10
2690 FOR J2=N1 TO 10
2700 E(N1-1)=E(N1-1)-E(J2)*A(N1-1,J2)
2710 NEXT J2
2720 E(N1-1)=E(N1-1)/A(N1-1,N1-1)
2730 N1=N1-1
2740 IF N1<>1 THEN GOTO  2690
```

```
2750 FOR I=1 TO 10
2760 P(I)=E(I)
2770 NEXT I
2780 FOR I=1 TO 10
2790 FOR J=1 TO 10
2800 A(I,J)=G(I,J)
2810 NEXT J:NEXT I
2820 C=12.011:O=15.9994:H=1.008:N=14.0067
2830 MWCO=C+O:MWCO2=C+O*2:MWNO2=N+O*2
2840 MWCHX=C+H*F(2)/F(1):MWCH4=C+H*4
2850 M=F(1)*C+F(2)*H
2860 EICO=P(6)*1000*MWCO/M
2870 EICO2=P(2)*1000*MWCO2/M
2880 EINOX=(P(9)+P(8))*1000*MWNO2/M
2890 EINO=P(9)*1000*MWNO2/M
2900 EINO2=P(8)*1000*MWNO2/M
2910 EICHX=P(7)*F(1)*1000*MWCHX/M
2920 EICH4=P(7)*F(1)*1000*MWCH4/M
2930 HHSD=1+C(4)
2940 COW=P(6)/P(1)*10^6
2950 COD=P(6)/(P(1)-P(5))*10^6
2960 COSD=COD/HHSD
2970 CO2W=P(2)/P(1)*100
2980 CO2D=P(2)/(P(1)-P(5))*100
2990 CO2SD=CO2D/HHSD
3000 NOXW=(P(8)+P(9))/P(1)*10^6
3010 NOXD=(P(8)+P(9))/(P(1)-P(5))*10^6
3020 NOXSD=NOXD/HHSD
3030 NOW=P(9)/P(1)*10^6
3040 NOD=P(9)/(P(1)-P(5))*10^6
3050 NOSD=NOD/HHSD
3060 NO2W=P(8)/P(1)*10^6
3070 NO2D=P(8)/(P(1)-P(5))*10^6
3080 NO2SD=NO2D/HHSD
3090 CXHYW=F(1)*P(7)/P(1)*10^6
3100 CXHYD=F(1)*P(7)/(P(1)-P(5))*10^6
3110 CXHYSD=CXHYD/HHSD
3120 O2D=P(4)/(P(1)-P(5))*100
3130 O2SD=O2D/HHSD
3140 O2W=P(4)/P(1)*100
3150 N2D=P(3)/(P(1)-P(5))*100
3160 N2SD=N2D/HHSD
3170 N2W=P(3)/P(1)*100
3180 K=(P(1)-P(5))/P(1)
3190 O2DM=1.00607*D(6)
3200 O2WM=O2DM*K
3210 H2O=P(5)/P(1)*100
3220 FA=(C(1)*C+C(2)*H)/28.965/P(10)
3230 N=(1-4.346*EICO/18730-EICHX/1000)*100
3240 F=NOXW*17.948/(20.948-O2W)
3250 G=NOXW*17.948/(20.948-O2WM)
3260 T=FF/1000
3270 WCO=T*EICO:WCO2=T*EICO2:WNOX=T*EINOX
3280 WCHX=T*EICHX:WCH4=T*EICH4:WSO2=T*SULF*20
3290 CLS:COLOR FG,0
```

```
3300 IF C(6)=1 THEN 3310 ELSE 3330
3310 H$="w"
3320 GOTO 3340
3330 H$="sd"
3340 'Delete the next step to print double strike on the IBM Proprinter.
3350 GOTO 3380
3360 LPRINT
3370 LPRINT CHR$(27);CHR$(71);
3380 IF X$="9" THEN 3390 ELSE 3680
3390 CLS:COLOR 15,0
3400 PRINT "Approximate emission indexes and emission rates for"
3410 PRINT "a ";
3420 COLOR 10,0:PRINT A$;
3430 COLOR 15,0:PRINT " engine at ";
3440 COLOR 10,0:PRINT B$;
3450 COLOR FG,0
3460 PRINT :PRINT :PRINT
3470 PRINT "CONSTITUENT                EMISSION INDEX           POUNDS PER HOUR"
3480 PRINT :PRINT
3490 PRINT TAB(1)"CARBON MONOXIDE";
3500 PRINT TAB(30)USING K$;EICO;
3510 PRINT TAB(55)USING K$;WCO:PRINT
3520 PRINT TAB(1)"CARBON DIOXIDE";
3530 PRINT TAB(30)USING K$;EICO2;
3540 PRINT TAB(55)USING K$;WCO2:PRINT
3550 PRINT TAB(1)"OXIDES OF NITROGEN (AS NO2)";
3560 PRINT TAB(30)USING K$;EINOX;
3570 PRINT TAB(55)USING K$;WNOX:PRINT
3580 PRINT TAB(1)"HYDROCARBONS (AS CHY/X)";
3590 PRINT TAB(30)USING K$;EICHX;
3600 PRINT TAB(55)USING K$;WCHX:PRINT
3610 PRINT TAB(1)"HYDROCARBONS (AS CH4)";
3620 PRINT TAB(30)USING K$;EICH4;
3630 PRINT TAB(55)USING K$;WCH4:PRINT
3640 PRINT TAB(1)"SULFUR (AS SO2)";
3650 PRINT TAB(30)USING K$;SULF*20;
3660 PRINT TAB(55)USING K$;WSO2:PRINT
3670 GOTO 6290
3680 IF KK=2 THEN 3690 ELSE 3700
3690 LPRINT:LPRINT
3700 LPRINT TAB(3)A$ TAB(23)B$ TAB(56)F$:COLOR FG,0
3710 LPRINT
3720 IF B(1)=0 THEN 3730 ELSE 3750
3730 LPRINT TAB(3)"J";
3740 GOTO 3760
3750 LPRINT TAB(3)"J  = "USING "##.##";B(1);
3760 IF C(7)=100 THEN 3770 ELSE 3790
3770 LPRINT TAB(21)"DEW ="USING "###.";C(8);
3780 GOTO 3820
3790 IF C(8)=0 THEN 3860
3800 IF C(7)=100 THEN 3850
3810 LPRINT TAB(21)"T   = "USING "##.";C(8);
3820 IF PRI=1 THEN 3830 ELSE 3850
3830 LPRINT  CHR$(248);"F";
3840 GOTO 3860
```

```
3850 LPRINT  CHR$(179);"F";
3860 LPRINT  TAB(48)"m = "USING "##.#";C(1)
3870 IF B(2)=0 THEN 3880 ELSE 3900
3880 LPRINT TAB(3)"L";
3890 GOTO 3910
3900 LPRINT TAB(3)"L  = "USING "##.#####";B(2);
3910 IF C(7)=0 THEN 3940
3920 IF C(7)=100 THEN 3940
3930 LPRINT TAB(21)"RH  = "USING "##%";C(7);
3940 LPRINT TAB(48)"n = "USING "##.#";C(2)
3950 IF B(3)=0 THEN 3960 ELSE 3980
3960 LPRINT TAB(3)"L'";
3970 GOTO 4000
3980 LPRINT TAB(3)"L' = "USING "##.##";B(3);
3990 IF C(9)=0 THEN 4020
4000 LPRINT TAB(21)"B   ="USING "###.##";C(9);
4010 LPRINT " in. Hg";
4020 LPRINT TAB(42)"NOx c/e = "USING "##.##";C(5)
4030 IF B(4)=0 THEN 4040 ELSE 4060
4040 LPRINT TAB(3)"M";
4050 GOTO 4070
4060 LPRINT TAB(3)"M  = "USING "##.#####";B(4);
4070 LPRINT TAB(21)"h   = "USING "##.######";C(3)
4080 IF B(5)=0 THEN 4090 ELSE 4110
4090 LPRINT TAB(3)"M'";
4100 GOTO 4120
4110 LPRINT TAB(3)"M' = "USING "##.##";B(5);
4120 IF PRI=1 THEN 4130 ELSE 4150
4130 LPRINT TAB(21)"h";
4140 GOTO 4170
4150 LPRINT TAB(21)"h"; CHR$(27);"&a+.5R";
4160 GOTO 4190
4170 LPRINT "sd = ";USING "##.#####";C(4)
4180 GOTO 4300
4190 LPRINT "sd"; CHR$(27);"&a-.5R";" = ";USING "##.#####";C(4)
4200 'Delete the next step to print the matrix and the matrix constant.
4210 GOTO 4300
4220 LPRINT:FOR I=1 TO 10
4230 LPRINT TAB(2)A(I,1) TAB(18)A(I,2) TAB(32)A(1,3);
4240 LPRINT TAB(46)A(I,4) TAB(60)A(I,5)
4250 LPRINT TAB(2)A(I,6) TAB(18)A(I,7) TAB(32)A(I,8);
4260 LPRINT TAB(46)A(I,9) TAB(60)A(I,10):LPRINT
4270 NEXT I
4280 FOR I=1 TO 10
4290 LPRINT F(I):NEXT I
4300 'Delete the next step to print the P vector.
4310 GOTO 4340
4320 LPRINT:LPRINT "P VECTOR"
4330 FOR I=1 TO 10:LPRINT E(I):NEXT I
4340 LPRINT
4350 LPRINT TAB(6)"CONSTITUENT" TAB(33)"EXHAUST CONCENTRATION";
4360 LPRINT TAB(60)"EMISSION"
4370 LPRINT TAB(27)"Measured"TAB(44)"Calculated"TAB(62)"INDEX"
4380 LPRINT TAB(41)"dry"TAB(47)"semi-"TAB(54)"wet"
4390 LPRINT TAB(48)"dry":LPRINT
```

```
4400 LPRINT TAB(2)"Carbon monoxide" TAB(23)"ppm";
4410 LPRINT TAB(27)USING J$;D(1);
4420 LPRINT "  sd";
4430 LPRINT TAB(38)USING J$;COD;
4440 LPRINT TAB(45)USING  J$;COSD;
4450 LPRINT TAB(52)USING J$;COW;
4460 LPRINT TAB(59)USING K$;EICO
4470 LPRINT TAB(2)"Carbon dioxide" TAB(24)"%";
4480 LPRINT TAB(29)USING "##.##";D(2);
4490 LPRINT  " sd";
4500 LPRINT TAB(38)USING N$;CO2D;
4510 LPRINT TAB(45)USING N$;CO2SD;
4520 LPRINT TAB(52)USING N$;CO2W;
4530 LPRINT TAB(59)USING K$;EICO2
4540 LPRINT TAB(2)"Oxides of nitrogen"TAB(23)"ppm";
4550 LPRINT TAB(27)USING J$;D(3);
4560 LPRINT "  ";H$;
4570 LPRINT TAB(38)USING J$;NOXD;
4580 LPRINT TAB(45)USING J$;NOXSD;
4590 LPRINT TAB(52) USING J$;NOXW;
4600 LPRINT TAB(59) USING K$;EINOX
4610 LPRINT TAB(2)"Nitric oxide"TAB(23)"ppm";
4620 IF FLAG=1 THEN 4650
4630 LPRINT TAB(27)USING J$;D(4);
4640 LPRINT "  ";H$;
4650 LPRINT TAB(38)USING J$;NOD;
4660 LPRINT TAB(45)USING J$;NOSD;
4670 LPRINT TAB(52)USING J$;NOW;
4680 LPRINT TAB(59)USING K$;EINO
4690 LPRINT TAB(2)"Nitrogen dioxide"TAB(23)"ppm";
4700 LPRINT TAB(38)USING J$;NO2D;
4710 LPRINT TAB(45)USING J$;NO2SD;
4720 LPRINT TAB(52)USING J$;NO2W;
4730 LPRINT TAB(59)USING K$;EINO2
4740 LPRINT TAB(2)"Hydrocarbons, CHy/x"TAB(23)"ppmC";
4750 LPRINT TAB(27)USING J$;D(5);
4760 LPRINT "  w";
4770 LPRINT TAB(38)USING J$;CXHYD;
4780 LPRINT TAB(45)USING J$;CXHYSD;
4790 LPRINT TAB(52)USING J$;CXHYW;
4800 LPRINT TAB(59)USING K$;EICHX
4810 LPRINT TAB(2)"Hydrocarbons, methane";
4820 LPRINT TAB(59)USING K$;EICH4
4830 LPRINT TAB(2)"Oxygen" TAB(24)"%";
4840 IF D(6)=0 THEN 4870
4850 LPRINT TAB(29)USING "##.#";D(6);
4860 LPRINT "  sd";
4870 LPRINT TAB(38)USING N$;O2D;
4880 LPRINT TAB(45)USING N$;O2SD;
4890 LPRINT TAB(52)USING  N$;O2W
4900 LPRINT TAB(2)"Nitrogen"TAB(24)"%"TAB(38)USING  N$;N2D;
4910 LPRINT TAB(45)USING  N$;N2SD;
4920 LPRINT TAB(52)USING N$;N2W
4930 LPRINT TAB(2)"Water, calc."TAB(24)"%"TAB(52)USING N$;H2O
4940 LPRINT
```

```
4950 LPRINT TAB(2)"Sulfur dioxide, calc."TAB(59)USING K$;SULF*20
4960 LPRINT
4970 LPRINT TAB(2)"Oxides of nitrogen at 3% oxygen, calc.(ppm wet)";
4980 LPRINT TAB(52)USING "####";F
4990 LPRINT TAB(2)"Oxides of nitrogen at 3% oxygen, meas.(ppm wet)";
5000 IF D(6)=0 THEN 5010 ELSE 5020
5010 LPRINT :GOTO 5030
5020 LPRINT TAB(52)USING "####";G
5030 LPRINT
5040 LPRINT TAB(2)"K = "USING "#.####";K
5050 LPRINT TAB(2)"F/A = "USING "#.######";FA
5060 LPRINT TAB(2)"Combustion efficiency = "USING "##.##%";N
5070 IF TH=0 THEN 5090
5080 LPRINT TAB(2)"Thrust =";TH;"pounds"
5090 IF HP=0 THEN 5110
5100 LPRINT TAB(2)"Shaft horsepower =";HP
5110 IF RPM=0 THEN LPRINT:GOTO 5130
5120 LPRINT TAB(2)"Engine speed =";RPM;"rpm"
5130 IF EGT=0 THEN LPRINT:GOTO 5200
5140 LPRINT TAB(2)"Engine exhaust temperature =";USING "#####";EGT;
5150 IF PRI=1 THEN 5180 ELSE 5160
5160 LPRINT CHR$(179);"F"
5170 GOTO 5190
5180 LPRINT CHR$(248);"F"
5190 CLS:COLOR FG:CLS
5200 CLS:COLOR FG
5210 IF TH=0 THEN 5220 ELSE 5230
5220 IF HP=0 THEN LPRINT ELSE 5230
5230 IF FF=0 THEN 5240 ELSE 5280
5240 FOR I=1 TO 10
5250 LPRINT
5260 NEXT I
5270 GOTO 5380
5280 LPRINT
5290 LPRINT TAB(2)"EMISSION RATE (pounds of constituent per hour)"
5300 LPRINT TAB(2)"for a fuel flow rate of";FF;
5310 LPRINT "pounds per hour":LPRINT
5320 LPRINT TAB(2)"Carbon monoxide"TAB(24)USING K$;WCO
5330 LPRINT TAB(2)"Carbon dioxide"TAB(24)USING K$;WCO2
5340 LPRINT TAB(2)"Oxides of nitrogen"TAB(24)USING K$;WNOX
5350 LPRINT TAB(2)"Hydrocarbons, CHy/x"TAB(24)USING K$;WCHX
5360 LPRINT TAB(2)"Hydrocarbons, methane";TAB(24)USING K$;WCH4
5370 LPRINT TAB(2)"Sulfur dioxide"TAB(24)USING K$;WSO2
5380 LPRINT
5390 LPRINT TAB(2)"Measurement by  ";M$
5400 LPRINT TAB(2)"Measurement at  ";P$
5410 LPRINT TAB(2)"Date of measurement  ";D$
5420 LPRINT TAB(2)"Engine S/N  ";SN$
5430 LPRINT TAB(2)R$
5440 LPRINT TAB(2)RR$
5450 COLOR FG,0:CLS
5460 IF PRI=1 THEN 5470 ELSE 5530
5470 PRINT "1 MOVES OPERATION TO THE END OF THE PROGRAM."
5480 PRINT "2 PRINTS ANOTHER COPY"
5490 PRINT "3 CONTINUES CALCULATION WITH NEXT POWER SETTING"
```

```
5500 PRINT:COLOR FG,BG
5510 INPUT "SELECT NUMBER";KK
5520 ON KK GOTO 6280,3700,1710
5530 COLOR FG,0:CLS
5540 PRINT "1 MOVES OPERATION TO THE END OF THE PROGRAM AND FEEDS DATA SHEET."
5550 PRINT "2 CONTINUES CALCULATION WITH NEXT POWER SETTING"
5560 PRINT "3 ADDS RULES AND BOLD LETTERS TO THE DATA SHEET IF THE"
5570 PRINT "  PRINTER HAS THE HP92286 FONT CARTRIDGE (LASERJET ONLY)."
5580 PRINT:COLOR FG,BG
5590 INPUT "SELECT NUMBER";KK
5600 ON KK GOTO 6260,5630,5650
5610 LPRINT CHR$(12)
5620 GOTO 6280
5630 LPRINT CHR$(12)
5640 GOTO 1710
5650 LPRINT  CHR$(27);"(0B";
5660 LPRINT  CHR$(27)+"&a5L";
5670 LPRINT  CHR$(27)+"&a1R";
5680 LPRINT "R,,7,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
,,,,T";
5690 LPRINT ".    .
    .";
5700 LPRINT  CHR$(27)"+&a2R";
5710 LPRINT "5,,/,,,,,,,,,,,,,,,,,,,7,,,,,,,,,,,,,,,,,,,,7,,,,,,,,,,,,,,,,,,,,,,,,
,,,,6";
5720 FOR I - 1 TO 5
5730 LPRINT ".    .                 .                    .
    .";
5740 NEXT I
5750 LPRINT  CHR$(27)"&a9R";
5760 LPRINT "5,,/,,,,,,,,,,,,,,,,,,,8,,,,,,,,,,,,,,,,,,,,8,,,,,,,,,,,,,,,,,,7,,,,,
,,,,6";
5770 FOR I - 1 TO 15
5780 LPRINT ".    .                                                         .
    .";
5790 NEXT I
5800 LPRINT  CHR$(27)"&a25R";
5810 LPRINT "5,,/,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,/,,,,,
,,,,6";
5820 LPRINT ".    .                                                         .
    .";
5830 LPRINT  CHR$(27)"&a27R";
5840 LPRINT "5,,/,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,8,,,,,
,,,,6";
5850 LPRINT ".    .
    .";
5860 LPRINT ".    .
    .";
5870 LPRINT  CHR$(27)"&a30R";
5880 LPRINT "5,,/,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
,,,,6";
5890 FOR I - 1 TO 6
5900 LPRINT ".    .
    .";
5910 NEXT I
```

```
5920 LPRINT  CHR$(27)"&a37R";
5930 LPRINT "5,,/,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
,,,,6";
5940 FOR I - 1 TO 9
5950 LPRINT ".  .
     .";
5960 NEXT I
5970 LPRINT  CHR$(27)"&a47R";
5980 LPRINT "5,,/,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
,,,,6";
5990 FOR I - 1 TO 6
6000 LPRINT ".  .
     .";
6010 NEXT I
6020 LPRINT  CHR$(27)"&a54R";
6030 LPRINT "F,,8,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
,,,,G";
6040 LPRINT  CHR$(27)+"(0U"; CHR$(27)+"(slp8v";
6050 LPRINT  CHR$(27)+"&a3r20C";
6060 LPRINT "A"
6070 LPRINT  CHR$(27)+"&a7r20C";
6080 LPRINT "B"
6090 LPRINT  CHR$(27)+"&a18.0r20C";
6100 LPRINT "C"
6110 LPRINT  CHR$(27)+"&a27.0r20C";
6120 LPRINT "D"
6130 LPRINT  CHR$(27)+"&a29.5r20C";
6140 LPRINT "E"
6150 LPRINT  CHR$(27)+"&a34.5r20C";
6160 LPRINT "F"
6170 LPRINT  CHR$(27)+"&a42.5r20C";
6180 LPRINT "G"
6190 LPRINT  CHR$(27)+"&a51.5r20C";
6200 LPRINT "H"
6210 LPRINT CHR$(27);"E";
6220 LPRINT CHR$(27);"&a0R";
6230 IF PRI-1 THEN 6240 ELSE 6280
6240 LPRINT  CHR$(27); CHR$(72);
6250 GOTO 6280
6260 LPRINT CHR$(12)
6270 IF KK-2 THEN 3680 ELSE 6280
6280 COLOR 7,0:CLS
6290 STOP
```

```
1 'Program listing  -  SAMPFL
2 'AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE, SEPTEMBER 1987 (jak)
3 '
4 'This program describes the use of a file to load data into program MATEI
5 'or MATEIE The lines numbered 10 or multiples of 10, and line 71, are the
6 'program. All other lines are instructions.  Load File T56001M (stored as a
7 'BASIC program) and RUN to place it on a formatted disk in drive 'a'.  These
8 'instructions show which variables need to be  (continued on line 12)
9 '
10 'OPEN "a:T56001M" FOR OUTPUT AS #1:F$="File T56001M"
11 '
12 'changed for each power setting of the engine.  Figure 4-3 of paragraph
13 '4.5.1 shows the print-out obtained by using file T56001M in program
14 'MATEIE.
15 '
16 'Enter the name of the file in line 10.
17 '
18 'In line 20, specify the engine and the power setting.
19 '
20 'A$="T56-A-16":B$="MILITARY"
21 '
22 'In line 30, tell who made the measurement.
23 '
30 'M$="AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE"
31 '
32 'In line 40, give the place of the measurement
33 '
40 'P$="NAVAIREWORKFAC ALAMEDA"
41 '
42 'In line 50, enter the date of the measurement.
43 '
50 'D$=23 "JUNE 1976"
51 '
52 'In line 60, enter the engine serial number.  Make no entry between
53 'the quotation marks if the serial number is not known.
54 '
60 'SN$="102138"
61 '
62 'In lines 70 and 71, write whatever you wish between the quotation marks,
63 'for two lines (up to 80 characters per line) of remarks.
64 '
70 'R$=" "
71 'RR$=" "
72 '
73 'In line 80, enter the fuel flow rate in pounds per hour.
74 '
80 'FF=2219
81 '
82 'In line 90, enter the engine speed as rpm.
83 '
90 'RPM=13820
91 '
92 'In line 100, for engines rated in thrust, enter the thrust in pounds.
93 'Enter zero in line 100 if the engine is rated in horsepower.
```

```
94 '
100 'TH=3890
101 '
102 'In line 110, for engines rated in horsepower, enter the horsepower.
103 'Enter zero in line 110 if the engine is rated in pounds thrust.
104 '
110 'HP=0
111 '
112 'In line 120, enter the engine exhaust temperature.  The calculation
113 'of emission indexes, from the measured concentration of the constituents,
114 'does not use rpm, thrust or engine exhaust temperature.  These variables
115 'may be useful in other studies.
116 '
120 'EGT=1970
121 '
122 'In line 130, enter the sulfur content of the fuel.  In this example the
123 'sulfur content of the fuel is 0.02%.
124 '
130 'SULF=0.02:'%
131 '
132 'In line 140 enter the instrument interference coefficients
133 'in the following order: J, L, L',M, M'.
134 '
140 'DATA -.07,-.0001,.14,-.00033,.28
141 '
142 'In line 150, enter (1),(2) the molecular constants (m and n) of the fuel,
143 '(3) h, (4) hsd, (5) efficiency of the NOx converter, (6) 1 (if NOx meas-
144 'urement was wet), or 2 (if NOx measurement was semi-dry), (7) relative
145 'humidity (%) (for dew point measurements let the relative humidity equal
146 '100%), (8) dry bulb temperature in degrees F, and (9) barometric
147 'pressure (in. Hg). If (7), (8), and (9) are zeros, program MATEI uses
148 'the value of h as entered, otherwise it calculates a value for h.
149 '
150 'DATA 13,23.4,0,.00607,.95,2,15,97,29.97
151 '
152 ' In line 160 enter the measured concentrations of (1) carbon monoxide
153 '(ppm), (2) carbon dioxide (%), (3) oxides of nitrogen (ppm), (4) nitric
154 'oxide (ppm), if measured (or zero in not measured), (5) hydrocarbons (ppm)
155 'and (6) oxygen (%).
156 '
160 'DATA 11.1,2.21,67.1,0,2.9,17.6
161 '
162 'Program steps 170 to 250 are the same for all files.
163 '
170 'WRITE #1,A$,B$,F$,M$,SN$,R$,RR$,FF,TH,RPM,HP,EGT,SULF
180 'FOR I=I to 5:READ B(I):NEXT I
190 'FOR I=1 TO 9:READ C(I):NEXT I
200 'FOR I=1 TO 6:READ D(I):NEXT I
210 'PRINT #1,B(1);B(2);B(3);B(4);B(5)
220 'PRINT #1,C(1);C(2);C(3);C(4);C(5);C(6);C(7);C(8);C(9)
230 'PRINT #1,D(1);D(2);D(3);D(4);D(5);D(6)
240 CLOSE #1
250 END
251 '
252 'Page B-19 gives the program listing for T56001M.
```

```
10 OPEN "a:T56001M" FOR OUTPUT AS #1:F$-"File T56001M"
20 A$-"T56-A-16":B$-"MILITARY"
30 M$-"AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE"
40 P$-"NAVAIREWORKFAC ALAMEDA"
50 D$-"23 JUNE 1976"
60 SN$-"102138"
70 R$-"Test Cell 11, single point probe in test cell exhaust stack."
71 RR$-"JP-5 fuel."
80 FF-2219
90 RPM-13820
100 TH-0
110 HP-4090
120 EGT-1970
130 SULF-.02:'%
140 DATA -.07,-0.00010,.14,-0.00033,.28
150 DATA 13,23.4,.0067,.00607,.95,2,15,97,29.86
160 DATA 11.1,2.21,67.1,0,2.9,17.6
170 WRITE #1,A$,B$,F$,M$,P$,D$,SN$,R$,RR$,FF,TH,RPM,HP,EGT,SULF
180 FOR I-1 TO 5:READ B(I):NEXT I
190 FOR I-1 TO 9:READ C(I):NEXT I
200 FOR I-1 TO 6:READ D(I):NEXT I
210 PRINT#1,B(1);B(2);B(3);B(4);B(5)
220 PRINT#1,C(1);C(2);C(3);C(4);C(5);C(6);C(7);C(8);C(9)
230 PRINT#1,D(1);D(2);D(3);D(4);D(5);D(6)
240 CLOSE #1
250 END
```

APPENDIX C

Data Sheets

INDEX OF DATA SHEETS IN APPENDIX C

ENGINE	POWER SETTING	FILE
TF30-P-6C	Idle	TF30020I
	30% Thrust	TF30020B
	75% Thrust	TF30020C
	Normal rated	TF30020N
	Military	TF30020M
TF30-P-412A	Idle	TF30021I
	75% Thrust	TF30021B
	Normal rated	TF30021N
	Military	TF30021M
	Afterburner zone 5	TF30021A
TF34-GE-400	Idle	TF34001I
	75% rpm	TF34001B
	Military	TF34001M
TF41-A-2	Idle	TF41001I
	8000 rpm	TF41001B
	9000 rpm	TF41001C
	10000 rpm	TF41001D
	75% Maximum continuous	TF41001E
	90% Maximum continuous	TF41001N
	Intermediate	TF41003M
J52-P-6B	Idle	J52001I
	3000 lbs Thrust	J52001B
	75% Thrust	J52001C
	Normal rated	J52001N
	Military	J52001M
J52-P-8B	Idle	J52010I
	Manual idle	J52010MI
	3000 lbs Thrust	J52010B
	75% Thrust	J52010C
	Normal rated	J52010N
	Military	J52010M
J57-P-10	Idle	J57001I
	75% Thrust	J57001B
	Normal rated	J57001N
	Military	J57001M
J57-P-420	Idle	J57021I
	30% Thrust	J57021B
	75% Thrust	J57021C
	96% rpm	J57021D
	Normal rated	J57021N
	Intermediate	J57021M
	Afterburner	J57021A

INDEX OF DATA SHEETS IN APPENDIX C (continued)

ENGINE	POWER SETTING	FILE
J65-W-5F	Idle	J65001I
	7450 rpm	J65001B
	8000 rpm	J65001C
	8300 rpm	J65001D
	Military	J65001M
J79-GE-8D	Idle	J79001I
	75% rpm	J79001B
	87% rpm	J79001C
	90% Normal rated	J79001D
	Military	J79001M
	Afterburner	J79020A
J79-GE-10B	Idle	J79BB01I
	30% Thrust	J79BB01B
	85% rpm	J79BB01C
	75% Thrust	J79BB01D
	Intermediate	J79BB01M
	Afterburner	J79BB01A
J79-GE-8B	Idle	J79002I
	75% rpm	J79002B
	87% rpm	J79002C
	90% rpm	J79002D
	95% rpm	J79002E
	Military	J79002M
J79-GE-8B	Idle	J79F02I
	75% rpm	J79F02B
	87% rpm	J79F02C
	90% rpm	J79F02D
	95% rpm	J79F02E
	Military	J79F02M
7LM1500-PB-104A	Idle	LM1501I
	75% Thrust	LM1501B
	Normal rated	LM1501N
	Intermediate	LM1501M
LM2500	Idle	LM2501I
	7235 rpm	LM2501B
	7708 rpm	LM2501C
	7814 rpm	LM2501D
	7949 rpm	LM2501E
	8046 rpm	LM2501F
	8190 rpm	LM2501G
	8210 rpm	LM2501H
	8297 rpm	LM2501J
	8415 rpm	LM2501K

INDEX OF DATA SHEETS IN APPENDIX C (continued)

INDEX OF DATA SHEETS IN APPENDIX C (concluded)

A	TF30–P–6C	IDLE	File TF30020I

B			
	J = −0.07 L = −0.0001 L′ = 0.14 M = −0.00033 M′ = 0.28	T = 71°F RH = 39% B = 29.98 in. Hg H = 0.009949 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	116.9	sd	115.3	114.6	113.8	70.58
Carbon dioxide	%	0.35	sd	0.35	0.35	0.34	3339.56
Oxides of nitrogen	ppm	2.0	sd	2.0	2.0	2.0	2.03
Nitric oxide	ppm			2.0	1.9	1.9	1.97
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.06
Hydrocarbons, $CH_{y/x}$	ppmC	42.2	w	42.7	42.5	42.2	12.92
Hydrocarbons, CH_4							14.99
Oxygen	%			20.51	20.39	20.25	
Nitrogen	%			79.13	78.65	78.12	
Water	%					1.27	

D Sulfur dioxide, calc. 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 51
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9873
F/A = 0.001577
Combustion efficiency = 97.07%
Thrust = 645 pounds
Engine speed
Engine exhaust temperature = 676°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 670 pounds per hour

Carbon monoxide	47.29
Carbon dioxide	2237.50
Oxides of nitrogen	1.36
Hydrocarbons, $CH_{y/x}$	8.66
Hydrocarbons, CH_4	10.04
Sulfur dioxide	0.27

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 1 JULY 1976
Engine S/N 652061
Test Cell 15, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF30-P-6C	30% THRUST	File TF30020B

B			
	J = −0.07 L = −0.0001 L′ = 0.14 M = −0.00033 M′ = 0.28	T = 71°F RH = 39% B = 29.98 in. Hg H = 0.009949 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	35.9	sd	33.6	33.4	33.2	14.87
Carbon dioxide	%	0.49	sd	0.49	0.48	0.48	3376.83
Oxides of nitrogen	ppm	6.5	sd	6.6	6.5	6.5	4.77
Nitric oxide	ppm			6.4	6.3	6.3	4.62
Nitrogen dioxide	ppm			0.2	0.2	0.2	0.15
Hydrocarbons, $CH_{y/x}$	ppmC	8.3	w	8.4	8.4	8.3	1.84
Hydrocarbons, CH_4							2.13
Oxygen	%			20.33	20.21	20.05	
Nitrogen	%			79.18	78.70	78.08	
Water	%					1.39	

D

Sulfur dioxide, calc. 0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 129
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9861
F/A = 0.002182
Combustion efficiency = 99.47%
Thrust = 3400 pounds
Engine speed
Engine exhaust temperature = 735°F

G

EMISSION RATE 'pounds of constituent per hour)
for a fuel flow rate of 2030 pounds per hour

Carbon monoxide	30.19
Carbon dioxide	6854.97
Oxides of nitrogen	9.68
Hydrocarbons, $CH_{y/x}$	3.73
Hydrocarbons, CH_4	4.33
Sulfur dioxide	0.81

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 1 JULY 1976
Engine S/N 652061
Test Cell 15, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF30-P-6C	75% THRUST	File TF30020C

B

J = −0.07	T = 71°F	m = 13.0
L = −0.0001	RH = 39%	n = 23.4
L' = 0.14	B = 29.98 in. Hg	η = 0.95
M = −0.00033	H = 0.009949	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	17.2	sd	14.6	14.6	14.4	4.75
Carbon dioxide	%	0.66	sd	0.65	0.65	0.64	3337.67
Oxides of nitrogen	ppm	13.7	sd	13.8	13.8	13.6	7.38
Nitric oxide	ppm			13.4	13.3	13.2	7.14
Nitrogen dioxide	ppm			0.4	0.4	0.4	0.23
Hydrocarbons, $CH_{y/x}$	ppmC	3.3	w	3.4	3.3	3.3	0.54
Hydrocarbons, CH_4							0.62
Oxygen	%			20.10	19.98	19.79	
Nitrogen	%			79.24	78.76	78.02	
Water	%					1.54	

D Sulfur dioxide, calc. — 0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 212
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9846
F/A = 0.002972
Combustion efficiency = 99.84%
Thrust = 6275 pounds
Engine speed
Engine exhaust temperature = 856°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 3560 pounds per hour

Carbon monoxide	16.92
Carbon dioxide	11882.12
Oxides of nitrogen	26.26
Hydrocarbons, $CH_{y/x}$	1.91
Hydrocarbons, CH_4	2.22
Sulfur dioxide	1.42

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 1 JULY 1976
Engine S/N 652061
Test Cell 15, single point probe, 85 feet behind engine.
JP-5 fuel.

A	**TF30-P-6C**	**NORMAL RATED**	**File TF30020N**
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 71°F RH = 39% B = 29.98 in. Hg H = 0.009949 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	11.2	sd	8.5	8.4	8.4	2.31
	Carbon dioxide	%	0.78	sd	0.77	0.77	0.76	3314.95
	Oxides of nitrogen	ppm	21.8	sd	22.0	21.9	21.7	9.86
	Nitric oxide	ppm			21.3	21.2	21.0	9.55
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.31
	Hydrocarbons, $CH_{y/x}$	ppmC	5.1	w	5.2	5.2	5.1	0.70
	Hydrocarbons, CH_4							0.81
	Oxygen	%			19.94	19.82	19.61	
	Nitrogen	%			79.28	78.80	77.98	
	Water	%					1.64	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 291
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9836
F/A = 0.003535
Combustion efficiency = 99.88%
Thrust = 8395 pounds
Engine speed
Engine exhaust temperature = 950°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4830 pounds per hour

Carbon monoxide	11.18
Carbon dioxide	16011.20
Oxides of nitrogen	47.64
Hydrocarbons, $CH_{y/x}$	3.37
Hydrocarbons, CH_4	3.91
Sulfur dioxide	1.93

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 1 JULY 1976
Engine S/N 652061
Test Cell 15, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF30-P-6C	MILITARY	File TF30020M

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 71°F RH = 39% B = 29.98 in. Hg H = 0.009949 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	10.1	sd	7.2	7.2	7.1	1.56
	Carbon dioxide	%	0.97	sd	0.96	0.96	0.95	3287.67
	Oxides of nitrogen	ppm	36.8	sd	37.2	37.0	36.5	13.28
	Nitric oxide	ppm			36.0	35.8	35.4	12.86
	Nitrogen dioxide	ppm			1.2	1.2	1.2	0.42
	Hydrocarbons, $CH_{y/x}$	ppmC	8.3	w	8.5	8.4	8.3	0.91
	Hydrocarbons, CH_4							1.05
	Oxygen	%			19.68	19.57	19.33	
	Nitrogen	%			79.35	78.87	77.92	
	Water	%					1.80	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 405
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9820
F/A = 0.004430
Combustion efficiency = 99.87%
Thrust = 11025 pounds
Engine speed
Engine exhaust temperature = 1074°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 6700 pounds per hour

Carbon monoxide	10.48
Carbon dioxide	22027.41
Oxides of nitrogen	88.98
Hydrocarbons, $CH_{y/x}$	6.08
Hydrocarbons, CH_4	7.05
Sulfur dioxide	2.68

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 1 JULY 1976
Engine S/N 652061
Test Cell 15, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF30-P-412A	IDLE	File TF30021I

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 93°F RH = 22% B = 29.95 in. Hg H = 0.011470 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	64.7	sd	62.8	62.5	62.0	55.51
	Carbon dioxide	%	0.25	sd	0.25	0.25	0.24	3440.59
	Oxides of nitrogen	ppm	2.2	sd	2.2	2.2	2.2	3.22
	Nitric oxide	ppm			2.2	2.1	2.1	3.12
	Nitrogen dioxide	ppm			0.1	0.1	0.1	0.10
	Hydrocarbons, $CH_{y/x}$	ppmC	71.1	w	72.1	71.6	71.1	31.42
	Hydrocarbons, CH_4							36.46
	Oxygen	%			20.65	20.52	20.37	
	Nitrogen	%			79.10	78.62	78.04	
	Water	%					1.33	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 69
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9867
F/A = 0.001094
Combustion efficiency = 95.57%
Thrust = 595 pounds
Engine speed = 10278 rpm
Turbine inlet temperature = 910°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 920 pounds per hour

Carbon monoxide	51.07
Carbon dioxide	3165.34
Oxides of nitrogen	2.96
Hydrocarbons, $CH_{y/x}$	28.90
Hydrocarbons, CH_4	33.54
Sulfur dioxide	0.37

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 679326
Test Cell 16, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF30-P-412A	75% THRUST	File TF30021B

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 93°F RH = 22% B = 29.95 in. Hg h = 0.011470 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	9.6	sd	7.2	7.2	7.1	3.43
Carbon dioxide	%	0.46	sd	0.46	0.45	0.45	3413.00
Oxides of nitrogen	ppm	13.6	sd	13.7	13.7	13.5	10.74
Nitric oxide	ppm			13.3	13.2	13.1	10.40
Nitrogen dioxide	ppm			0.4	0.4	0.4	0.34
Hydrocarbons, $CH_{y/x}$	ppmC	6.2	w	6.3	6.3	6.2	1.48
Hydrocarbons, CH_4							1.72
Oxygen	%			20.37	20.25	20.06	
Nitrogen	%			79.17	78.69	77.98	
Water	%					1.51	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 275
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9849
F/A = 0.002027
Combustion efficiency = 99.77%
Thrust = 7070 pounds
Engine speed = 13441 rpm
Turbine inlet temperature = 1570°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4300 pounds per hour

Carbon monoxide	14.74
Carbon dioxide	14675.89
Oxides of nitrogen	46.19
Hydrocarbons, $CH_{y/x}$	6.36
Hydrocarbons, CH_4	7.38
Sulfur dioxide	1.72

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 679326
Test Cell 16, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF30-P-412A	NORMAL RATED	File TF30021N

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 93°F RH = 22% B = 29.95 in. Hg h = 0.011470 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	6.7	sd	4.2	4.2	4.1	1.62
	Carbon dioxide	%	0.56	sd	0.56	0.55	0.55	3371.58
	Oxides of nitrogen	ppm	25.0	sd	25.3	25.1	24.9	16.02
	Nitric oxide	ppm			24.5	24.3	24.1	15.52
	Nitrogen dioxide	ppm			0.8	0.8	0.8	0.51
	Hydrocarbons, $CH_{y/x}$	ppmC	6.2	w	6.3	6.3	6.2	1.20
	Hydrocarbons, CH_4							1.39
	Oxygen	%			20.24	20.11	19.91	
	Nitrogen	%			79.20	78.73	77.94	
	Water	%					1.60	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 431
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9840
F/A = 0.002497
Combustion efficiency = 99.84%
Thrust = 9550 pounds
Engine speed = 14105 rpm
Turbine inlet temperature = 1806°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 5980 pounds per hour

Carbon monoxide	9.66
Carbon dioxide	20162.07
Oxides of nitrogen	95.82
Hydrocarbons, $CH_{y/x}$	7.18
Hydrocarbons, CH_4	8.34
Sulfur dioxide	2.39

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 679326
Test Cell 16, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF30-P-412A	MILITARY	File TF30021M

B

J = -0.07	T = 93°F	m = 13.0
L = -0.0001	RH = 22%	n = 23.4
L' = 0.14	B = 29.95 in. Hg	η = 0.95
M = -0.00033	h = 0.011470	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	6.7	sd	4.1	4.1	4.0	1.38
Carbon dioxide	%	0.64	sd	0.63	0.63	0.62	3347.82
Oxides of nitrogen	ppm	35.2	sd	35.6	35.3	35.0	19.60
Nitric oxide	ppm			34.4	34.2	33.9	18.98
Nitrogen dioxide	ppm			1.1	1.1	1.1	0.62
Hydrocarbons, $CH_{y/x}$	ppmC	4.6	w	4.7	4.6	4.6	0.77
Hydrocarbons, CH_4							0.90
Oxygen	%			20.13	20.01	19.79	
Nitrogen	%			79.23	78.75	77.91	
Water	%					1.66	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 544
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9834
F/A = 0.002874
Combustion efficiency = 99.89%
Thrust = 10900 pounds
Engine speed = 14505 rpm
Turbine inlet temperature = 1958°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7050 pounds per hour

Carbon monoxide	9.71
Carbon dioxide	23602.14
Oxides of nitrogen	138.20
Hydrocarbons, $CH_{y/x}$	5.46
Hydrocarbons, CH_4	6.34
Sulfur dioxide	2.82

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 679326
Test Cell 16, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF30-P-412A	AFTERBURNER ZONE 5	File TF30021A
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 93°F RH = 22% B = 29.95 in. Hg H = 0.011470 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	246.6	sd	241.5	240.1	229.5	10.77
	Carbon dioxide	%	4.57	sd	4.55	4.52	4.32	3188.56
	Oxides of nitrogen	ppm	64.4	sd	65.4	65.0	62.1	4.79
	Nitric oxide	ppm			63.4	63.0	60.2	4.64
	Nitrogen dioxide	ppm			2.1	2.1	2.0	0.15
	Hydrocarbons, $CH_{y/x}$	ppmC	8.8	w	9.3	9.2	8.8	0.20
	Hydrocarbons, CH_4							0.24
	Oxygen	%			14.80	14.71	14.06	
	Nitrogen	%			80.62	80.14	76.59	
	Water	%					5.00	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 162
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9500
F/A = 0.021252
Combustion efficiency = 99.73%
Thrust = 18850 pounds
Engine speed = 14460 rpm
Turbine inlet temperature = 1970°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 47800 pounds per hour

Carbon monoxide	514.91
Carbon dioxide	152413.20
Oxides of nitrogen	229.04
Hydrocarbons, $CH_{y/x}$	9.75
Hydrocarbons, CH_4	11.31
Sulfur dioxide	19.12

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 679326
Test Cell 16, single point probe, 85 feet behind engine.
JP-5 fuel.

A	TF34-GE-400	IDLE	File TF34001I

B

J = -0.07	T = 59°F	m = 13.0
L = -0.0009	RH = 64%	n = 23.4
L' = 0.14	B = 29.92 in. Hg	η = 0.95
M = -0.00504	h = 0.010723	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	211.9	sd	178.9	177.9	176.4	90.98
Carbon dioxide	%	0.41	sd	0.41	0.40	0.40	3248.66
Oxides of nitrogen	ppm	2.0	sd	2.0	2.0	2.0	1.69
Nitric oxide	ppm			2.0	1.9	1.9	1.63
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.05
Hydrocarbons, $CH_{y/x}$	ppmC	58.9	w	59.7	59.4	58.9	14.99
Hydrocarbons, CH_4							17.40
Oxygen	%			20.42	20.30	20.14	
Nitrogen	%			79.15	78.67	78.04	
Water	%					1.41	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 44
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9859
F/A = 0.001899
Combustion efficiency = 96.39%
Thrust = 950 pounds
Engine speed = 11600 rpm

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 485 pounds per hour

Carbon monoxide	44.13
Carbon dioxide	1575.60
Oxides of nitrogen	0.82
Hydrocarbons, $CH_{y/x}$	7.27
Hydrocarbons, CH_4	8.44
Sulfur dioxide	0.19

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAL AIR STATION, NORTH ISLAND
Date of measurement 13,14 NOVEMBER 1975
Engine S/N 202110
TF34 Test Cell, single point probe in test cell exhaust. JP-5 fuel.
The thrust was not measured. The listed value is typical for this engine.

A	**TF34-GE-400**	**75% rpm**	**File TF34001B**

B	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00504 M' = 0.28	T = 59°F RH = 64% B = 29.92 in. Hg h = 0.010723 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	102.2	sd	68.3	67.9	67.3	33.57
Carbon dioxide	%	0.44	sd	0.44	0.43	0.43	3369.69
Oxides of nitrogen	ppm	4.2	sd	4.2	4.2	4.2	3.42
Nitric oxide	ppm			4.1	4.1	4.0	3.32
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.11
Hydrocarbons, $CH_{y/x}$	ppmC	10.7	w	10.9	10.8	10.7	2.63
Hydrocarbons, CH_4							3.06
Oxygen	%			20.39	20.27	20.10	
Nitrogen	%			79.16	78.69	78.04	
Water	%					1.42	

D Sulfur dioxide, calc. 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 89
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9858
F/A = 0.001964
Combustion efficiency = 98.96%
Thrust = 960 pounds
Engine speed = 12000 rpm

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 460 pounds per hour

Carbon monoxide	15.44
Carbon dioxide	1550.06
Oxides of nitrogen	1.58
Hydrocarbons, $CH_{y/x}$	1.21
Hydrocarbons, CH_4	1.41
Sulfur dioxide	0.18

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAL AIR STATION, NORTH ISLAND
Date of measurement 13,14 NOVEMBER 1975
Engine S/N 202110
TF34 Test Cell, single point probe in test cell exhaust. JP-5 fuel.
The thrust was not measured. The listed value is typical for this engine.

A	TF34-GE-400	MILITARY	File TF34001M

B			
	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00504 M' = 0.28	T = 59°F RH = 64% B = 29.92 in. Hg h = 0.010723 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	60.2	sd	22.7	22.6	22.3	5.95
Carbon dioxide	%	0.81	sd	0.80	0.80	0.79	3304.70
Oxides of nitrogen	ppm	17.3	sd	17.5	17.4	17.2	7.51
Nitric oxide	ppm			16.9	16.8	16.6	7.28
Nitrogen dioxide	ppm			0.6	0.5	0.5	0.24
Hydrocarbons, $CH_{y/x}$	ppmC	3.0	w	3.1	3.0	3.0	0.39
Hydrocarbons, CH_4							0.46
Oxygen	%			19.90	19.78	19.55	
Nitrogen	%			79.29	78.81	77.91	
Water	%					1.74	

D Sulfur dioxide, calc. — 0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 221
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9826
F/A = 0.003682
Combustion efficiency = 99.82%
Thrust = 9275 pounds
Engine speed = 16500 rpm

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 3800 pounds per hour

Carbon monoxide	22.62
Carbon dioxide	12557.87
Oxides of nitrogen	28.56
Hydrocarbons, $CH_{y/x}$	1.50
Hydrocarbons, CH_4	1.74
Sulfur dioxide	1.52

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAL AIR STATION, NORTH ISLAND
Date of measurement 13,14 NOVEMBER 1975
Engine S/N 202110
TF34 Test Cell, single point probe in test cell exhaust. JP-5 fuel.
The thrust was not measured. The listed value is typical for this engine.

A	TF41-A-2	IDLE	File TF41001I

B			
	J = −0.07 L = −0.0001 L′ = 0.14 M = −0.00033 M′ = 0.28	T = 93°F RH = 22% B = 29.90 in. Hg H = 0.011490 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	267.3	sd	266.4	264.8	262.1	94.80
	Carbon dioxide	%	0.55	sd	0.55	0.54	0.54	3050.49
	Oxides of nitrogen	ppm	2.9	sd	2.9	2.9	2.9	1.71
	Nitric oxide	ppm			2.8	2.8	2.8	1.66
	Nitrogen dioxide	ppm			0.1	0.1	0.1	0.05
	Hydrocarbons, $CH_{y/x}$	ppmC	287.1	w	291.8	290.0	287.1	51.26
	Hydrocarbons, CH_4							59.48
	Oxygen	%			20.23	20.10	19.90	
	Nitrogen	%			79.20	78.72	77.92	
	Water	%					1.61	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 49
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9839
F/A = 0.002711
Combustion efficiency = 92.67%
Thrust = 595 pounds
Engine speed = 7100 rpm
Engine exhaust temperature = 908°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1090 pounds per hour

Carbon monoxide	103.33
Carbon dioxide	3325.03
Oxides of nitrogen	1.87
Hydrocarbons, $CH_{y/x}$	55.87
Hydrocarbons, CH_4	64.83
Sulfur dioxide	0.44

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 141917
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	TF41-A-2	8000 RPM	File TF41001B

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 93°F RH = 22% B = 29.90 in. Hg H = 0.011490 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	236.5	sd	235.4	234.0	231.7	88.70
Carbon dioxide	%	0.53	sd	0.53	0.52	0.52	3112.35
Oxides of nitrogen	ppm	3.6	sd	3.6	3.6	3.6	2.25
Nitric oxide	ppm			3.5	3.5	3.5	2.18
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.07
Hydrocarbons, $CH_{y/x}$	ppmC	201.8	w	205.1	203.8	201.8	38.14
Hydrocarbons, CH_4							44.26
Oxygen	%			20.26	20.13	19.93	
Nitrogen	%			79.19	78.72	77.93	
Water	%					1.59	

D Sulfur dioxide, calc. 0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 63
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9841
F/A = 0.002561
Combustion efficiency = 94.13%
Thrust = 820 pounds
Engine speed = 8000 rpm
Engine exhaust temperature = 846°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1230 pounds per hour

Carbon monoxide	109.10
Carbon dioxide	3828.19
Oxides of nitrogen	2.77
Hydrocarbons, $CH_{y/x}$	46.91
Hydrocarbons, CH_4	54.43
Sulfur dioxide	0.49

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 141917
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	TF41-A-2	9000 RPM	File TF41001C

B

J = -0.07	T = 93°F	m = 13.0
L = -0.0001	RH = 22%	n = 23.4
L' = 0.14	B = 29.90 in. Hg	η = 0.95
M = -0.00033	H = 0.011490	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	166.3	sd	164.8	163.8	162.1	60.41
Carbon dioxide	%	0.56	sd	0.56	0.55	0.55	3200.23
Oxides of nitrogen	ppm	4.7	sd	4.7	4.7	4.7	2.86
Nitric oxide	ppm			4.6	4.6	4.5	2.77
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.09
Hydrocarbons, $CH_{y/x}$	ppmC	124.5	w	126.5	125.8	124.5	22.90
Hydrocarbons, CH_4							26.58
Oxygen	%			20.22	20.10	19.90	
Nitrogen	%			79.20	78.73	77.93	
Water	%					1.61	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 80
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9839
F/A = 0.002631
Combustion efficiency = 96.31%
Thrust = 1210 pounds
Engine speed = 9020 rpm
Engine exhaust temperature = 850°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1500 pounds per hour

Carbon monoxide	90.62
Carbon dioxide	4800.34
Oxides of nitrogen	4.29
Hydrocarbons, $CH_{y/x}$	34.35
Hydrocarbons, CH_4	39.86
Sulfur dioxide	0.60

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 141917
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	TF41-A-2	10000 RPM	File TF41001D

B			
	J = −0.07	T = 93°F	m = 13.0
	L = −0.0001	RH = 22%	n = 23.4
	L′ = 0.14	B = 29.90 in. Hg	η = 0.95
	M = −0.00033	H = 0.011490	
	M′ = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	121.4	sd	119.5	118.8	117.6	42.30
	Carbon dioxide	%	0.59	sd	0.59	0.58	0.58	3253.88
	Oxides of nitrogen	ppm	6.2	sd	6.3	6.2	6.2	3.64
	Nitric oxide	ppm			6.1	6.0	6.0	3.53
	Nitrogen dioxide	ppm			0.2	0.2	0.2	0.11
	Hydrocarbons, $CH_{y/x}$	ppmC	73.0	w	74.2	73.8	73.0	12.96
	Hydrocarbons, CH_4							15.04
	Oxygen	%			20.19	20.06	19.86	
	Nitrogen	%			79.22	78.74	77.92	
	Water	%					1.63	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 101
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9837
F/A = 0.002726
Combustion efficiency = 97.72%
Thrust = 1800 pounds
Engine speed = 10029 rpm
Engine exhaust temperature = 871°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1880 pounds per hour

Carbon monoxide	79.53
Carbon dioxide	6117.30
Oxides of nitrogen	6.84
Hydrocarbons, $CH_{y/x}$	24.37
Hydrocarbons, CH_4	28.28
Sulfur dioxide	0.75

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 141917
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	TF41-A-2	75% MAXIMUM CONTINUOUS	File TF41001E

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 93°F RH = 22% B = 29.90 in. Hg H = 0.011490 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	12.4	sd	9.6	9.5	9.4	2.17
	Carbon dioxide	%	0.93	sd	0.92	0.92	0.91	3292.14
	Oxides of nitrogen	ppm	44.7	sd	45.2	44.9	44.3	16.85
	Nitric oxide	ppm			43.8	43.5	42.9	16.32
	Nitrogen dioxide	ppm			1.4	1.4	1.4	0.53
	Hydrocarbons, $CH_{y/x}$	ppmC	6.4	w	6.5	6.5	6.4	0.73
	Hydrocarbons, CH_4							0.85
	Oxygen	%			19.74	19.62	19.36	
	Nitrogen	%			79.33	78.86	77.81	
	Water	%					1.92	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 500
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9808
F/A = 0.004242
Combustion efficiency = 99.88%
Thrust = 9550 pounds
Engine speed = 12056 rpm
Engine exhaust temperature = 1020°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 6000 pounds per hour

Carbon monoxide	13.01
Carbon dioxide	19752.85
Oxides of nitrogen	101.09
Hydrocarbons, $CH_{y/x}$	4.39
Hydrocarbons, CH_4	5.09
Sulfur dioxide	2.40

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 24 JUNE 1976
Engine S/N 141917
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	TF41-A-2	90% MAXIMUM CONTINUOUS	File TF41001N

B			
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 93°F RH = 22% B = 29.90 in. Hg h = 0.011490 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	11.0	sd	8.0	8.0	7.9	1.62
	Carbon dioxide	%	1.04	sd	1.03	1.03	1.01	3280.21
	Oxides of nitrogen	ppm	67.5	sd	68.2	67.8	66.9	22.67
	Nitric oxide	ppm			66.1	65.7	64.7	21.95
	Nitrogen dioxide	ppm			2.2	2.1	2.1	0.71
	Hydrocarbons, $CH_{y/x}$	ppmC	8.2	w	8.4	8.3	8.2	0.84
	Hydrocarbons, CH_4							0.97
	Oxygen	%			19.59	19.47	19.19	
	Nitrogen	%			79.37	78.89	77.77	
	Water	%					2.01	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 684

Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9799

F/A = 0.004759

Combustion efficiency = 99.88%

Thrust = 11500 pounds

Engine speed = 12460 rpm

Engine exhaust temperature = 1118°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7480 pounds per hour

Carbon monoxide	12.15
Carbon dioxide	24535.96
Oxides of nitrogen	169.56
Hydrocarbons, $CH_{y/x}$	6.25
Hydrocarbons, CH_4	7.25
Sulfur dioxide	2.99

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE

Measurement at NAVAIREWORKFAC ALAMEDA

Date of measurement 24 JUNE 1976

Engine S/N 141917

Test Cell 15, single point probe 85 feet behind engine exhaust plane.

JP-5 fuel.

A

TF41-A-2 | **INTERMEDIATE** | **File TF41003M**

B

J = -0.07	T = 69°F	m = 13.0
L = -0.0001	RH = 59%	n = 23.4
L' = 0.14	B = 29.93 in. Hg	η = 0.95
M = -0.00033	H = 0.014107	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	12.4	sd	9.3	9.2	9.1	1.64
Carbon dioxide	%	1.19	sd	1.18	1.17	1.15	3267.64
Oxides of nitrogen	ppm	76.8	sd	77.6	77.2	75.8	22.46
Nitric oxide	ppm			75.2	74.7	73.4	21.75
Nitrogen dioxide	ppm			2.4	2.4	2.4	0.71
Hydrocarbons, $CH_{y/x}$	ppmC	7.2	w	7.4	7.3	7.2	0.64
Hydrocarbons, CH_4							0.74
Oxygen	%	19.0	sd	19.39	19.27	18.92	
Nitrogen	%			79.42	78.95	77.52	
Water	%					2.39	

D

Sulfur dioxide, calc. 0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 671
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 594

F

K = 0.9761
F/A = 0.005464
Combustion efficiency = 99.90%
Thrust = 14000 pounds
Engine speed
Engine exhaust temperature = 1138°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 8940 pounds per hour

Carbon monoxide	14.63
Carbon dioxide	29212.69
Oxides of nitrogen	200.76
Hydrocarbons, $CH_{y/x}$	5.73
Hydrocarbons, CH_4	6.65
Sulfur dioxide	3.58

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 8 JULY 1976
Engine S/N 141369
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-6B	IDLE	File J520011

B			
	J = −0.07 L = −0.0001 L' = 0.14 M = −0.00033 M' = 0.28	T = 70°F RH = 49% B = 29.84 in. Hg H = 0.012150 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	195.0	sd	193.7	192.6	190.6	86.37
	Carbon dioxide	%	0.46	sd	0.46	0.45	0.45	3196.13
	Oxides of nitrogen	ppm	2.8	sd	2.8	2.8	2.8	2.07
	Nitric oxide	ppm			2.7	2.7	2.7	2.01
	Nitrogen dioxide	ppm			0.1	0.1	0.1	0.07
	Hydrocarbons, $CH_{y/x}$	ppmC	106.8	w	108.5	107.9	106.8	23.88
	Hydrocarbons, CH_4							27.71
	Oxygen	%	20.3	sd	20.35	20.23	20.03	
	Nitrogen	%			79.17	78.69	77.91	
	Water	%					1.59	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 54
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 59

F

K = 0.9841
F/A = 0.002165
Combustion efficiency = 95.61%
Thrust = 512 pounds
Engine speed = 6926 rpm
Engine exhaust temperature = 501°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 714 pounds per hour

Carbon monoxide	61.67
Carbon dioxide	2282.03
Oxides of nitrogen	1.48
Hydrocarbons, $CH_{y/x}$	17.05
Hydrocarbons, CH_4	19.79
Sulfur dioxide	0.29

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 17 JUNE 1976
Engine S/N 649773
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-6B	3000 LBS THRUST	File J52001B

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 70°F RH = 49% B = 29.84 in. Hg H = 0.012150 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	52.9	sd	50.6	50.3	49.7	16.57
	Carbon dioxide	%	0.65	sd	0.64	0.64	0.63	3319.80
	Oxides of nitrogen	ppm	7.2	sd	7.3	7.2	7.1	3.91
	Nitric oxide	ppm			7.0	7.0	6.9	3.79
	Nitrogen dioxide	ppm			0.2	0.2	0.2	0.12
	Hydrocarbons, $CH_{y/x}$	ppmC	5.0	w	5.1	5.1	5.0	0.82
	Hydrocarbons, CH_4							0.96
	Oxygen	%	20.1	sd	20.11	19.99	19.76	
	Nitrogen	%			79.24	78.76	77.86	
	Water	%					1.74	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 108
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 119

F

K = 0.9826
F/A = 0.002943
Combustion efficiency = 99.53%
Thrust = 3034 pounds
Engine speed = 9770 rpm
Engine exhaust temperature = 638°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 2301 pounds per hour

Carbon monoxide	38.13
Carbon dioxide	7638.86
Oxides of nitrogen	9.01
Hydrocarbons, $CH_{y/x}$	1.89
Hydrocarbons, CH_4	2.20
Sulfur dioxide	0.92

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 17 JUNE 1976
Engine S/N 649773
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-6B	75% THRUST	File J52001C

B

J = -0.07	T = 70°F	m = 13.0
L = -0.0001	RH = 49%	n = 23.4
L′ = 0.14	B = 29.84 in. Hg	η = 0.95
M = -0.00033	H = 0.012150	
M′ = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	28.3	sd	25.6	25.4	25.1	6.00
Carbon dioxide	%	0.90	sd	0.89	0.89	0.88	3290.12
Oxides of nitrogen	ppm	15.0	sd	15.2	15.1	14.9	5.84
Nitric oxide	ppm			14.7	14.6	14.4	5.65
Nitrogen dioxide	ppm			0.5	0.5	0.5	0.18
Hydrocarbons, $CH_{y/x}$	ppmC	5.5	w	5.6	5.6	5.5	0.65
Hydrocarbons, CH_4							0.75
Oxygen	%	19.9	sd	19.78	19.66	19.39	
Nitrogen	%			79.33	78.85	77.77	
Water	%					1.96	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	171
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	202

F

K = 0.9804
F/A = 0.004108
Combustion efficiency = 99.80%
Thrust = 5446 pounds
Engine speed = 10641 rpm
Engine exhaust temperature = 822°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 3977 pounds per hour

Carbon monoxide	23.35
Carbon dioxide	13084.82
Oxides of nitrogen	23.22
Hydrocarbons, $CH_{y/x}$	2.58
Hydrocarbons, CH_4	3.00
Sulfur dioxide	1.59

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 17 JUNE 1976
Engine S/N 649773
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	**J52-P-6B**	**NORMAL RATED**	**File J52001N**
B	J = --0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 70°F RH = 49% B = 29.84 in. Hg H = 0.012150 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	25.3	sd	22.4	22.3	22.0	4.53
	Carbon dioxide	%	1.04	sd	1.03	1.03	1.01	3276.40
	Oxides of nitrogen	ppm	22.3	sd	22.5	22.4	22.1	7.48
	Nitric oxide	ppm			21.8	21.7	21.4	7.24
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.24
	Hydrocarbons, $CH_{y/x}$	ppmC	5.5	w	5.6	5.6	5.5	0.56
	Hydrocarbons, CH_4							0.65
	Oxygen	%			19.59	19.47	19.18	
	Nitrogen	%			79.37	78.90	77.72	
	Water	%					2.08	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 224
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9792
F/A = 0.004765
Combustion efficiency = 99.84%
Thrust = 7202 pounds
Engine speed = 11177 rpm
Engine exhaust temperature = 945°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 5366 pounds per hour

Carbon monoxide	24.31
Carbon dioxide	17581.18
Oxides of nitrogen	40.14
Hydrocarbons, $CH_{y/x}$	3.01
Hydrocarbons, CH_4	3.49
Sulfur dioxide	2.15

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 17 JUNE 1976
Engine S/N 649773
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-6B	MILITARY	File J52001M

B			
	J = -0.07	T = 70°F	m = 13.0
	L = -0.0001	RH = 49%	n = 23.4
	L' = 0.14	B = 29.84 in. Hg	η = 0.95
	M = -0.00033	H = 0.012150	
	M' = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	19.2	sd	16.2	16.1	15.8	3.01
	Carbon dioxide	%	1.13	sd	1.12	1.11	1.10	3271.29
	Oxides of nitrogen	ppm	29.2	sd	29.5	29.3	28.9	9.00
	Nitric oxide	ppm			28.6	28.4	28.0	8.72
	Nitrogen dioxide	ppm			0.9	0.9	0.9	0.28
	Hydrocarbons, $CH_{y/x}$	ppmC	3.5	w	3.6	3.6	3.5	0.33
	Hydrocarbons, CH_4							0.38
	Oxygen	%	19.7	sd	19.47	19.35	19.05	
	Nitrogen	%			79.41	78.93	77.69	
	Water	%					2.16	

D	Sulfur dioxide, calc.	0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	273
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	333

F

K = 0.9784
F/A = 0.005183
Combustion efficiency = 99.90%
Thrust = 8275 pounds
Engine speed = 11500 rpm
Engine exhaust temperature = 1033°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 6328 pounds per hour

Carbon monoxide	19.02
Carbon dioxide	20700.70
Oxides of nitrogen	56.96
Hydrocarbons, $CH_{y/x}$	2.07
Hydrocarbons, CH_4	2.41
Sulfur dioxide	2.53

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 17 JUNE 1976
Engine S/N 649773
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-8B	IDLE	File J52010I

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 73°F RH = 44% B = 29.93 in. Hg h = 0.012091 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	149.1	sd	147.5	146.6	145.2	63.78
Carbon dioxide	%	0.47	sd	0.47	0.46	0.46	3166.50
Oxides of nitrogen	ppm	2.5	sd	2.5	2.5	2.5	1.79
Nitric oxide	ppm			2.4	2.4	2.4	1.74
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.06
Hydrocarbons, $CH_{y/x}$	ppmC	194.6	w	197.7	196.6	194.6	42.20
Hydrocarbons, CH_4							48.96
Oxygen	%	20.2	sd	20.34	20.22	20.02	
Nitrogen	%			79.17	78.69	77.91	
Water	%					1.59	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	48
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	47

F

K = 0.9841
F/A = 0.002233
Combustion efficiency = 94.30%
Thrust = 475 pounds
Engine speed = 6625 rpm
Engine exhaust temperature = 492°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 680 pounds per hour

Carbon monoxide	43.37
Carbon dioxide	2153.22
Oxides of nitrogen	1.22
Hydrocarbons, $CH_{y/x}$	28.69
Hydrocarbons, CH_4	33.30
Sulfur dioxide	0.27

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 29 JUNE 1976
Engine S/N 661421
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-8B	MANUAL IDLE	File J52010MI

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 73°F RH = 44% B = 29.93 in. Hg h = 0.012091 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	139.1	sd	137.5	136.7	135.4	69.51
	Carbon dioxide	%	0.40	sd	0.40	0.39	0.39	3149.76
	Oxides of nitrogen	ppm	2.2	sd	2.2	2.2	2.2	1.84
	Nitric oxide	ppm			2.2	2.1	2.1	1.79
	Nitrogen dioxide	ppm			0.1	0.1	0.1	0.06
	Hydrocarbons, $CH_{y/x}$	ppmC	221.7	w	225.1	223.8	221.7	56.16
	Hydrocarbons, CH_4							65.16
	Oxygen	%			20.44	20.32	20.13	
	Nitrogen	%			79.15	78.67	77.94	
	Water	%					1.53	

D	Sulfur dioxide, calc.	0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 48
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9847
F/A = 0.001911
Combustion efficiency = 92.77%
Engine speed = 6350 rpm

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 640 pounds per hour

Carbon monoxide	44.48
Carbon dioxide	2015.85
Oxides of nitrogen	1.18
Hydrocarbons, $CH_{y/x}$	35.94
Hydrocarbons, CH_4	41.70
Sulfur dioxide	0.26

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 29 JUNE 1976
Engine S/N 661421
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	**J52-P-8B**	**3000 LBS THRUST**	**File J52010B**

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 73°F RH = 44% B = 29.93 in. Hg h = 0.012091 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	36.1	sd	33.6	33.4	33.0	10.54
	Carbon dioxide	%	0.68	sd	0.67	0.67	0.66	3319.15
	Oxides of nitrogen	ppm	12.2	sd	12.3	12.3	12.1	6.34
	Nitric oxide	ppm			11.9	11.9	11.7	6.14
	Nitrogen dioxide	ppm			0.4	0.4	0.4	0.20
	Hydrocarbons, $CH_{y/x}$	ppmC	10.9	w	11.1	11.0	10.9	1.72
	Hydrocarbons, CH_4							1.99
	Oxygen	%	19.9	sd	20.07	19.95	19.72	
	Nitrogen	%			79.25	78.77	77.85	
	Water	%					1.76	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	177
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	170

F

K = 0.9824
F/A = 0.003079
Combustion efficiency = 99.58%
Thrust = 3005 pounds
Engine speed = 9866 rpm
Engine exhaust temperature = 637°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 2300 pounds per hour

Carbon monoxide	24.23
Carbon dioxide	7634.04
Oxides of nitrogen	14.58
Hydrocarbons, $CH_{y/x}$	3.94
Hydrocarbons, CH_4	4.58
Sulfur dioxide	0.92

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 29 JUNE 1976
Engine S/N 661421
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-8B	75% THRUST	File J52010C

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 73°F RH = 44% B = 29.93 in. Hg h = 0.012091 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	17.0	sd	14.1	14.0	13.8	3.00
Carbon dioxide	%	0.99	sd	0.98	0.98	0.96	3284.13
Oxides of nitrogen	ppm	28.6	sd	28.9	28.7	28.3	10.10
Nitric oxide	ppm			28.0	27.8	27.4	9.78
Nitrogen dioxide	ppm			0.9	0.9	0.9	0.32
Hydrocarbons, $CH_{y/x}$	ppmC	5.4	w	5.5	5.5	5.4	0.58
Hydrocarbons, CH_4							0.67
Oxygen	%	19.5	sd	19.66	19.54	19.26	
Nitrogen	%			79.36	78.88	77.75	
Water	%					2.03	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 301
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 294

F

K = 0.9797
F/A = 0.004526
Combustion efficiency = 99.87%
Thrust = 5900 pounds
Engine speed = 10869 rpm
Engine exhaust temperature = 850°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4320 pounds per hour

Carbon monoxide	12.98
Carbon dioxide	14187.45
Oxides of nitrogen	43.64
Hydrocarbons, $CH_{y/x}$	2.50
Hydrocarbons, CH_4	2.90
Sulfur dioxide	1.73

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 29 JUNE 1976
Engine S/N 661421
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-8B	NORMAL RATED	File J52010N

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 73°F RH = 44% B = 29.93 in. Hg h = 0.012091 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	8.3	sd	5.1	5.1	5.0	0.87
	Carbon dioxide	%	1.23	sd	1.22	1.21	1.19	3266.06
	Oxides of nitrogen	ppm	42.9	sd	43.4	43.1	42.4	12.13
	Nitric oxide	ppm			42.0	41.8	41.1	11.75
	Nitrogen dioxide	ppm			1.4	1.4	1.3	0.38
	Hydrocarbons, $CH_{y/x}$	ppmC	6.9	w	7.1	7.0	6.9	0.59
	Hydrocarbons, CH_4							0.69
	Oxygen	%	19.4	sd	19.33	19.22	18.90	
	Nitrogen	%			79.44	78.96	77.67	
	Water	%					2.23	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 372
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 408

F

K = 0.9777
F/A = 0.005649
Combustion efficiency = 99.92%
Thrust = 8030 pounds
Engine speed = 11478 rpm
Engine exhaust temperature = 1041°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 6130 pounds per hour

Carbon monoxide	5.35
Carbon dioxide	20020.96
Oxides of nitrogen	74.36
Hydrocarbons, $CH_{y/x}$	3.64
Hydrocarbons, CH_4	4.22
Sulfur dioxide	2.45

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 29 JUNE 1976
Engine S/N 661421
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J52-P-8B	MILITARY	File J52010M
B	J = −0.07 L = −0.0001 L′ = 0.14 M = −0.00033 M′ = 0.28	T = 73°F RH = 44% B = 29.93 in. Hg h = 0.012091 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	8.1	sd	4.8	4.7	4.6	0.71
Carbon dioxide	%	1.40	sd	1.39	1.38	1.36	3254.59
Oxides of nitrogen	ppm	52.7	sd	53.3	53.0	52.0	13.05
Nitric oxide	ppm			51.6	51.3	50.4	12.64
Nitrogen dioxide	ppm			1.7	1.7	1.6	0.41
Hydrocarbons, $CH_{y/x}$	ppmC	12.3	w	12.6	12.5	12.3	0.93
Hydrocarbons, CH_4							1.08
Oxygen	%	19.1	sd	19.10	18.99	18.65	
Nitrogen	%			79.50	79.02	77.61	
Water	%					2.38	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc. (ppm wet) 406
Oxides of nitrogen at 3% oxygen, meas. (ppm wet) 426

F

K = 0.9762
F/A = 0.006449
Combustion efficiency = 99.89%
Thrust = 9200 pounds
Engine speed = 11906 rpm
Engine exhaust temperature = 1184°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7370 pounds per hour

Carbon monoxide	5.22
Carbon dioxide	23986.31
Oxides of nitrogen	96.16
Hydrocarbons, $CH_{y/x}$	6.83
Hydrocarbons, CH_4	7.93
Sulfur dioxide	2.95

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 29 JUNE 1976
Engine S/N 661421
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J57-P-10	IDLE	File J57001I

B

J = −0.07	T = 63°F	m = 13.0
L = −0.0001	RH = 67%	n = 23.4
L′ = 0.14	B = 29.97 in. Hg	η = 0.95
M = −0.00033	h = 0.012933	
M′ = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	237.4	sd	236.3	234.9	232.2	80.52
Carbon dioxide	%	0.55	sd	0.55	0.54	0.54	2920.94
Oxides of nitrogen	ppm	3.3	sd	3.3	3.3	3.3	1.87
Nitric oxide	ppm			3.2	3.2	3.2	1.81
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.06
Hydrocarbons, $CH_{y/x}$	ppmC	564.3	w	574.3	570.9	564.3	96.60
Hydrocarbons, CH_4							112.10
Oxygen	%			20.23	20.11	19.87	
Nitrogen	%			79.20	78.72	77.81	
Water	%					1.75	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 55
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9825
F/A = 0.002831
Combustion efficiency = 88.47%
Thrust = 555 pounds
Engine speed = 6009 rpm
Engine exhaust temperature = 519°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1100 pounds per hour

Carbon monoxide	88.57
Carbon dioxide	3213.04
Oxides of nitrogen	2.05
Hydrocarbons, $CH_{y/x}$	106.26
Hydrocarbons, CH_4	123.31
Sulfur dioxide	0.44

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 9 JULY 1976
Engine S/N 606306
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J57-P-10	75% THRUST	File J57001B

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 63°F RH = 67% B = 29.97 in. Hg h = 0.012933 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	18.3	sd	15.4	15.3	15.1	3.21
	Carbon dioxide	%	1.01	sd	1.00	1.00	0.98	3281.02
	Oxides of nitrogen	ppm	21.4	sd	21.6	21.5	21.2	7.40
	Nitric oxide	ppm			20.9	20.8	20.5	7.17
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.23
	Hydrocarbons, $CH_{y/x}$	ppmC	7.2	w	7.4	7.3	7.2	0.76
	Hydrocarbons, CH_4							0.88
	Oxygen	%			19.63	19.51	19.21	
	Nitrogen	%			79.36	78.88	77.68	
	Water	%					2.13	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 219
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9787
F/A = 0.004621
Combustion efficiency = 99.85%
Thrust = 7040 pounds
Engine speed = 8958 rpm
Engine exhaust temperature = 862°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 5670 pounds per hour

Carbon monoxide	18.20
Carbon dioxide	18603.40
Oxides of nitrogen	41.97
Hydrocarbons, $CH_{y/x}$	4.29
Hydrocarbons, CH_4	4.98
Sulfur dioxide	2.27

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 9 JULY 1976
Engine S/N 606306
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J57-P-10	NORMAL RATED	File J57001N

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 63°F RH = 67% B = 29.97 in. Hg h = 0.012933 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	13.0	sd	9.9	9.9	9.7	1.79
	Carbon dioxide	%	1.16	sd	1.15	1.14	1.13	3268.55
	Oxides of nitrogen	ppm	30.0	sd	30.3	30.1	29.6	9.00
	Nitric oxide	ppm			29.4	29.2	28.7	8.72
	Nitrogen dioxide	ppm			1.0	1.0	0.9	0.28
	Hydrocarbons, $CH_{y/x}$	ppmC	11.0	w	11.3	11.2	11.0	1.00
	Hydrocarbons, CH_4							1.16
	Oxygen	%	19.0	sd	19.43	19.31	18.99	
	Nitrogen	%			79.42	78.94	77.62	
	Water	%					2.26	
D	Sulfur dioxide, calc.							0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	272
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	235

F

K = 0.9774
F/A = 0.005325
Combustion efficiency = 99.86%
Thrust = 9050 pounds
Engine speed = 9267 rpm
Engine exhaust temperature = 968°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7250 pounds per hour

Carbon monoxide	13.00
Carbon dioxide	23696.99
Oxides of nitrogen	65.26
Hydrocarbons, $CH_{y/x}$	7.28
Hydrocarbons, CH_4	8.44
Sulfur dioxide	2.90

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 9 JULY 1976
Engine S/N 606306
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J57-P-10	MILITARY	File J57001M

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 63°F RH = 67% B = 29.97 in. Hg h = 0.012933 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	10.2	sd	7.0	7.0	6.8	1.16
	Carbon dioxide	%	1.26	sd	1.25	1.24	1.22	3262.61
	Oxides of nitrogen	ppm	37.6	sd	38.0	37.8	37.1	10.37
	Nitric oxide	ppm			36.8	36.6	36.0	10.04
	Nitrogen dioxide	ppm			1.2	1.2	1.2	0.33
	Hydrocarbons, $CH_{y/x}$	ppmC	10.3	w	10.5	10.5	10.3	0.86
	Hydrocarbons, CH_4							1.00
	Oxygen	%	19.0	sd	19.29	19.18	18.84	
	Nitrogen	%			79.45	78.97	77.59	
	Water	%					2.34	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 316
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 292

F

K = 0.9766
F/A = 0.005792
Combustion efficiency = 99.89%
Thrust = 10310 pounds
Engine speed = 9468 rpm
Engine exhaust temperature = 1043°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 8370 pounds per hour

Carbon monoxide	9.74
Carbon dioxide	27308.07
Oxides of nitrogen	86.78
Hydrocarbons, $CH_{y/x}$	7.23
Hydrocarbons, CH_4	8.40
Sulfur dioxide	3.35

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 9 JULY 1976
Engine S/N 606306
Test Cell 15, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J57-P-420	IDLE	File J57021I

B			
	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00209 M' = 0.28	T = 58°F RH = 90% B = 30.02 in. Hg H = 0.014564 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	252.2	sd	236.0	234.6	231.5	80.74
Carbon dioxide	%	0.56	sd	0.56	0.55	0.54	2985.39
Oxides of nitrogen	ppm	2.7	sd	2.7	2.7	2.7	1.53
Nitric oxide	ppm			2.6	2.6	2.6	1.48
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.05
Hydrocarbons, $CH_{y/x}$	ppmC	444.2	w	452.9	450.1	444.2	76.46
Hydrocarbons, CH_4							88.73
Oxygen	%			20.21	20.09	19.83	
Nitrogen	%			79.20	78.72	77.69	
Water	%					1.91	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	43
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9809
F/A = 0.002821
Combustion efficiency = 90.48%
Thrust = 393 pounds
Engine speed = 6794 rpm
Engine exhaust temperature = 479°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1322 pounds per hour

Carbon monoxide	106.74
Carbon dioxide	3946.69
Oxides of nitrogen	2.03
Hydrocarbons, $CH_{y/x}$	101.08
Hydrocarbons, CH_4	117.29
Sulfur dioxide	0.53

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 16 JANUARY 1974
Engine S/N 634012
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	**J57–P–420**	**30% THRUST**	**File J57021B**
B	J = −0.07 L = −0.0009 L' = 0.14 M = −0.00209 M' = 0.28	T = 58°F RH = 90% B = 30.02 in. Hg H = 0.014564 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	63.5	sd	45.4	45.1	44.5	14.83
	Carbon dioxide	%	0.65	sd	0.64	0.64	0.63	3310.23
	Oxides of nitrogen	ppm	8.2	sd	8.3	8.2	8.1	4.45
	Nitric oxide	ppm			8.0	8.0	7.9	4.31
	Nitrogen dioxide	ppm			0.3	0.3	0.3	0.14
	Hydrocarbons, $CH_{y/x}$	ppmC	27.6	w	28.2	28.0	27.6	4.54
	Hydrocarbons, CH_4							5.27
	Oxygen	%			20.11	19.99	19.72	
	Nitrogen	%			79.24	78.76	77.67	
	Water	%					1.98	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet) Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	118
F	K = 0.9802 F/A = 0.002952 Combustion efficiency = 99.20% Thrust = 3577 pounds Engine speed = 8407 rpm Engine exhaust temperature = 674°F	
G	EMISSION RATE (pounds of constituent per hour) for a fuel flow rate of 3413 pounds per hour Carbon monoxide 50.62 Carbon dioxide 11297.80 Oxides of nitrogen 15.17 Hydrocarbons, $CH_{y/x}$ 15.50 Hydrocarbons, CH_4 17.98 Sulfur dioxide 1.37	
H	Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE Measurement at NAVAIREWORKFAC NORTH ISLAND Date of measurement 16 JANUARY 1974 Engine S/N 634012 Test Cell 20, single point probe 95 feet behind engine exhaust plane. JP-5 fuel.	

A	J57-P-420	75% THRUST	File J57021C
B	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00209 M' = 0.28	T = 58°F RH = 90% B = 30.02 in. Hg H = 0.014564 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	36.5	sd	16.7	16.6	16.4	4.32
	Carbon dioxide	%	0.82	sd	0.81	0.81	0.80	3303.38
	Oxides of nitrogen	ppm	16.3	sd	16.5	16.4	16.1	6.99
	Nitric oxide	ppm			16.0	15.9	15.6	6.77
	Nitrogen dioxide	ppm			0.5	0.5	0.5	0.22
	Hydrocarbons, $CH_{y/x}$	ppmC	8.4	w	8.6	8.5	8.4	1.09
	Hydrocarbons, CH_4							1.27
	Oxygen	%			19.89	19.77	19.46	
	Nitrogen	%			79.30	78.82	77.62	
	Water	%					2.12	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet) Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	195
F	K = 0.9788 F/A = 0.003729 Combustion efficiency = 99.79% Thrust = 6946 pounds Engine speed = 9090 rpm Engine exhaust temperature = 841°F	

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 5767 pounds per hour

Carbon monoxide	24.91
Carbon dioxide	19050.60
Oxides of nitrogen	40.32
Hydrocarbons, $CH_{y/x}$	6.31
Hydrocarbons, CH_4	7.33
Sulfur dioxide	2.31

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 16 JANUARY 1974
Engine S/N 634012
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J57-P-420	96% RPM	File J57021D

B			
	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00209 M' = 0.28	T = 58°F RH = 90% B = 30.02 in. Hg H = 0.014564 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	27.0	sd	5.5	5.5	5.4	1.17
Carbon dioxide	%	1.00	sd	0.99	0.99	0.97	3284.34
Oxides of nitrogen	ppm	27.4	sd	27.7	27.5	27.1	9.58
Nitric oxide	ppm			26.8	26.7	26.2	9.28
Nitrogen dioxide	ppm			0.9	0.9	0.9	0.30
Hydrocarbons, $CH_{y/x}$	ppmC	10.2	w	10.4	10.4	10.2	1.09
Hydrocarbons, CH_4							1.26
Oxygen	%			19.64	19.53	19.20	
Nitrogen	%			79.36	78.88	77.56	
Water	%					2.27	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 277
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9773
F/A = 0.004571
Combustion efficiency = 99.86%
Thrust = 9139 pounds
Engine speed = 9569 rpm
Engine exhaust temperature = 996°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7667 pounds per hour

Carbon monoxide	8.96
Carbon dioxide	25181.04
Oxides of nitrogen	73.46
Hydrocarbons, $CH_{y/x}$	8.32
Hydrocarbons, CH_4	9.65
Sulfur dioxide	3.07

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 16 JANUARY 1974
Engine S/N 634012
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	**J57–P–420**	**NORMAL RATED**	**File J57021N**

B

J = −0.07	T = 58°F	m = 13.0
L = −0.0009	RH = 90%	n = 23.4
L' = 0.14	B = 30.02 in. Hg	η = 0.95
M = −0.00209	H = 0.014564	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	27.0	sd	5.7	5.7	5.6	1.23
Carbon dioxide	%	0.98	sd	0.97	0.97	0.95	3287.72
Oxides of nitrogen	ppm	25.7	sd	26.0	25.8	25.4	9.18
Nitric oxide	ppm			25.2	25.0	24.6	8.89
Nitrogen dioxide	ppm			0.8	0.8	0.8	0.29
Hydrocarbons, $CH_{y/x}$	ppmC	6.5	w	6.7	6.6	6.5	0.71
Hydrocarbons, CH_4							0.82
Oxygen	%			19.67	19.55	19.23	
Nitrogen	%			79.35	78.87	77.56	
Water	%					2.26	

EXHAUST CONCENTRATION

D Sulfur dioxide, calc. — 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 265
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9774
F/A = 0.004475
Combustion efficiency = 99.90%
Thrust = 9241 pounds
Engine speed = 9508 rpm
Engine exhaust temperature = 978°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7701 pounds per hour

Carbon monoxide	9.49
Carbon dioxide	25318.72
Oxides of nitrogen	70.70
Hydrocarbons, $CH_{y/x}$	5.44
Hydrocarbons, CH_4	6.31
Sulfur dioxide	3.08

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 16 JANUARY 1974
Engine S/N 634012
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J57-P-420	INTERMEDIATE	File J57021M

B	J = -0.07 L = -0.0008 L' = 0.14 M = -0.00209 M' = 0.28	T = 58°F RH = 90% B = 30.02 in. Hg H = 0.014564 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	24.1	sd	2.0	1.9	1.9	0.34
	Carbon dioxide	%	1.21	sd	1.20	1.19	1.17	3268.72
	Oxides of nitrogen	ppm	45.1	sd	45.6	45.3	44.5	12.97
	Nitric oxide	ppm			44.2	43.9	43.1	12.56
	Nitrogen dioxide	ppm			1.4	1.4	1.4	0.41
	Hydrocarbons, $CH_{y/x}$	ppmC	5.6	w	5.7	5.7	5.6	0.49
	Hydrocarbons, CH_4							0.57
	Oxygen	%			19.36	19.24	18.89	
	Nitrogen	%			79.43	78.95	77.48	
	Water	%					2.45	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 387
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9755
F/A = 0.005553
Combustion efficiency = 99.94%
Thrust = 12007 pounds
Engine speed = 10090 rpm
Engine exhaust temperature = 1184°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 10570 pounds per hour

Carbon monoxide	3.58
Carbon dioxide	34550.36
Oxides of nitrogen	137.13
Hydrocarbons, $CH_{y/x}$	5.19
Hydrocarbons, CH_4	6.02
Sulfur dioxide	4.23

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 16 JANUARY 1974
Engine S/N 634012
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J57–P–420	AFTERBURNER	File J57021A

B

J = −0.07	T = 58°F	m = 13.0
L = −0.0006	RH = 90%	n = 23.4
L′ = 0.14	B = 30.02 in. Hg	η = 0.95
M = −0.00209	H = 0.014564	
M′ = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	336.1	sd	299.8	298.0	284.7	14.20
Carbon dioxide	%	4.29	sd	4.27	4.24	4.05	3177.14
Oxides of nitrogen	ppm	65.4	sd	66.4	66.0	63.0	5.16
Nitric oxide	ppm			64.3	63.9	61.1	5.00
Nitrogen dioxide	ppm			2.1	2.1	2.0	0.16
Hydrocarbons, $CH_{y/x}$	ppmC	103.0	w	108.5	107.8	103.0	2.54
Hydrocarbons, CH_4							2.94
Oxygen	%			15.17	15.08	14.40	
Nitrogen	%			80.52	80.04	76.45	
Water	%					5.06	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 173
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9494
F/A = 0.020041
Combustion efficiency = 99.42%
Thrust = 18240 pounds
Engine speed = 10085 rpm
Engine exhaust temperature = 1179°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 39721 pounds per hour

Carbon monoxide	563.93
Carbon dioxide	126199.20
Oxides of nitrogen	205.13
Hydrocarbons, $CH_{y/x}$	100.71
Hydrocarbons, CH_4	116.87
Sulfur dioxide	15.89

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 16 JANUARY 1974
Engine S/N 634012
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J65-W-5F	IDLE	File J65001I
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 70°F RH = 45% B = 30.04 in. Hg H = 0.011072 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	201.7	sd	200.1	198.9	196.4	47.16
	Carbon dioxide	%	0.87	sd	0.86	0.86	0.85	3196.99
	Oxides of nitrogen	ppm	6.3	sd	6.4	6.3	6.2	2.46
	Nitric oxide	ppm			6.2	6.1	6.1	2.39
	Nitrogen dioxide	ppm			0.2	0.2	0.2	0.08
	Hydrocarbons, $CH_{y/x}$	ppmC	82.5	w	84.0	83.5	82.5	9.78
	Hydrocarbons, CH_4							11.35
	Oxygen	%	20.0	sd	19.80	19.68	19.44	
	Nitrogen	%			79.31	78.84	77.85	
	Water	%					1.84	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 74
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 94

F

K = 0.9816
F/A = 0.004087
Combustion efficiency = 97.93%
Thrust = 450 pounds
Engine speed = 4020 rpm
Engine exhaust temperature = 940°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1320 pounds per hour

Carbon monoxide	62.25
Carbon dioxide	4220.02
Oxides of nitrogen	3.25
Hydrocarbons, $CH_{y/x}$	12.91
Hydrocarbons, CH_4	14.98
Sulfur dioxide	0.53

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 22 JUNE 1976
Engine S/N 603118
Test Cell 1, single point probe in test cell exhaust stack.
JP-5 fuel.

A	**J65-W-5F**	**7450 rpm**	**File J65001B**
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 70°F RH = 45% B = 30.04 in. Hg H = 0.011072 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	55.9	sd	53.4	53.0	52.4	12.61
	Carbon dioxide	%	0.89	sd	0.88	0.88	0.87	3279.73
	Oxides of nitrogen	ppm	18.6	sd	18.8	18.7	18.4	7.30
	Nitric oxide	ppm			18.2	18.1	17.9	7.07
	Nitrogen dioxide	ppm			0.6	0.6	0.6	0.23
	Hydrocarbons, $CH_{y/x}$	ppmC	8.0	w	8.2	8.1	8.0	0.95
	Hydrocarbons, CH_4							1.10
	Oxygen	%	18.8	sd	19.79	19.67	19.42	
	Nitrogen	%			79.32	78.84	77.86	
	Water	%					1.85	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	217
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	139

F

K = 0.9815
F/A = 0.004075
Combustion efficiency = 99.61%
Thrust = 4710 pounds
Engine speed = 7450 rpm
Engine exhaust temperature = 915°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4370 pounds per hour

Carbon monoxide	55.11
Carbon dioxide	14332.42
Oxides of nitrogen	31.89
Hydrocarbons, $CH_{y/x}$	4.16
Hydrocarbons, CH_4	4.82
Sulfur dioxide	1.75

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 22 JUNE 1976
Engine S/N 603118
Test Cell 1, single point probe in test cell exhaust stack.
JP-5 fuel.

A	J65-W-5F	8000 rpm	File J65001C

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 70°F RH = 45% B = 30.04 in. Hg H = 0.011072 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	41.3	sd	38.5	38.2	37.7	7.39
	Carbon dioxide	%	1.09	sd	1.08	1.08	1.06	3266.45
	Oxides of nitrogen	ppm	17.9	sd	18.1	18.0	17.7	5.71
	Nitric oxide	ppm			17.5	17.4	17.2	5.53
	Nitrogen dioxide	ppm			0.6	0.6	0.6	0.18
	Hydrocarbons, $CH_{y/x}$	ppmC	7.4	w	7.6	7.5	7.4	0.72
	Hydrocarbons, CH_4							0.83
	Oxygen	%			19.52	19.40	19.13	
	Nitrogen	%			79.39	78.91	77.79	
	Water	%					2.02	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 175
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9798
F/A = 0.005008
Combustion efficiency = 99.76%
Thrust = 6380 pounds
Engine speed = 8000 rpm
Engine exhaust temperature = 1075°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 5970 pounds per hour

Carbon monoxide	44.13
Carbon dioxide	19500.71
Oxides of nitrogen	34.10
Hydrocarbons, $CH_{y/x}$	4.28
Hydrocarbons, CH_4	4.96
Sulfur dioxide	2.39

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 22 JUNE 1976
Engine S/N 603118
Test Cell 1, single point probe in test cell exhaust stack.
JP-5 fuel.

A	**J65–W–5F**	**8300 rpm**	**File J65001D**
B	$J = -0.07$ $L = -0.0001$ $L' = 0.14$ $M = -0.00033$ $M' = 0.28$	$T = 70°F$ $RH = 45\%$ $B = 30.04$ in. Hg $H = 0.011072$ $h_{sd} = 0.00607$	$m = 13.0$ $n = 23.4$ $\eta = 0.95$

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	29.7	sd	26.7	26.5	26.1	4.57
	Carbon dioxide	%	1.22	sd	1.21	1.20	1.19	3261.68
	Oxides of nitrogen	ppm	18.1	sd	18.3	18.2	17.9	5.15
	Nitric oxide	ppm			17.7	17.6	17.3	4.99
	Nitrogen dioxide	ppm			0.6	0.6	0.6	0.16
	Hydrocarbons, $CH_{y/x}$	ppmC	3.8	w	3.9	3.9	3.8	0.33
	Hydrocarbons, CH_4							0.38
	Oxygen	%			19.35	19.23	18.93	
	Nitrogen	%			79.44	78.96	77.75	
	Water	%					2.13	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 160
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9787
F/A = 0.005611
Combustion efficiency = 99.86%
Thrust = 7330 pounds
Engine speed = 8300 rpm
Engine exhaust temperature = 1180°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7040 pounds per hour

Carbon monoxide	32.19
Carbon dioxide	22962.25
Oxides of nitrogen	36.28
Hydrocarbons, $CH_{y/x}$	2.31
Hydrocarbons, CH_4	2.68
Sulfur dioxide	2.82

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 22 JUNE 1976
Engine S/N 603118
Test Cell 1, single point probe in test cell exhaust stack.
JP-5 fuel.

A	J65-W-5F	MILITARY	File J65001M

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 70°F RH = 45% B = 30.04 in. Hg h = 0.011072 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
C	Carbon monoxide	ppm	35.6	sd	32.5	32.3	31.8	5.31
	Carbon dioxide	%	1.28	sd	1.27	1.26	1.24	3255.43
	Oxides of nitrogen	ppm	19.3	sd	19.5	19.4	19.1	5.23
	Nitric oxide	ppm			18.9	18.8	18.5	5.06
	Nitrogen dioxide	ppm			0.6	0.6	0.6	0.16
	Hydrocarbons, $CH_{y/x}$	ppmC	7.4	w	7.6	7.5	7.4	0.61
	Hydrocarbons, CH_4							0.71
	Oxygen	%			19.27	19.15	18.84	
	Nitrogen	%			79.46	78.98	77.73	
	Water	%					2.18	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 163
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9782
F/A = 0.005897
Combustion efficiency = 99.82%
Thrust = 7250 pounds
Engine speed = 8311 rpm
Engine exhaust temperature = 1155°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 6946 pounds per hour

Carbon monoxide	36.86
Carbon dioxide	22612.21
Oxides of nitrogen	36.31
Hydrocarbons, $CH_{y/x}$	4.23
Hydrocarbons, CH_4	4.91
Sulfur dioxide	2.78

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 22 JUNE 1976
Engine S/N 603118
Test Cell 1, single point probe in test cell exhaust stack.
JP-5 fuel.

A	J79-GE-8D	IDLE	File J790011

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	h = 0.010000 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	169.3	sd	167.7	166.7	165.2	55.70
	Carbon dioxide	%	0.62	sd	0.62	0.61	0.61	3209.27
	Oxides of nitrogen	ppm	4.3	sd	4.3	4.3	4.3	2.37
	Nitric oxide	ppm			4.2	4.2	4.1	2.29
	Nitrogen dioxide	ppm			0.1	0.1	0.1	0.07
	Hydrocarbons, $CH_{y/x}$	ppmC	101.7	w	103.3	102.6	101.7	16.93
	Hydrocarbons, CH_4							19.64
	Oxygen	%			20.14	20.02	19.84	
	Nitrogen	%			79.23	78.75	78.02	
	Water	%					1.52	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 69
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9848
F/A = 0.002904
Combustion efficiency = 97.01%
Thrust = 259 pounds
Engine speed = 5012 rpm
Engine exhaust temperature = 608°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1205 pounds per hour

Carbon monoxide	67.12
Carbon dioxide	3867.17
Oxides of nitrogen	2.86
Hydrocarbons, $CH_{y/x}$	20.40
Hydrocarbons, CH_4	23.67
Sulfur dioxide	0.48

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 MAY 1977
Engine S/N 401917
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-8D	75% RPM	File J79001B

B

J = -0.07
L = -0.0001
L' = 0.14
M = -0.00033
M' = 0.28

h = 0.010000
h_{sd} = 0.00607

m = 13.0
n = 23.4
η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	72.0	sd	69.9	69.5	69.0	30.61
Carbon dioxide	%	0.49	sd	0.49	0.48	0.48	3341.62
Oxides of nitrogen	ppm	4.1	sd	4.1	4.1	4.1	2.98
Nitric oxide	ppm			4.0	4.0	4.0	2.88
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.09
Hydrocarbons, $CH_{y/x}$	ppmC	20.1	w	20.4	20.3	20.1	4.40
Hydrocarbons, CH_4							5.11
Oxygen	%			20.33	20.20	20.04	
Nitrogen	%			79.18	78.70	78.07	
Water	%					1.40	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 81
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9860
F/A = 0.002205
Combustion efficiency = 98.85%
Thrust = 1022 pounds
Engine speed = 5763 rpm
Engine exhaust temperature = 537°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1520 pounds per hour

Carbon monoxide	46.53
Carbon dioxide	5079.26
Oxides of nitrogen	4.52
Hydrocarbons, $CH_{y/x}$	6.69
Hydrocarbons, CH_4	7.77
Sulfur dioxide	0.61

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 MAY 1977
Engine S/N 401917
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	**J79–GE–8D**	**87% RPM**	**File J79001C**

B	J = −0.07 L = −0.0001 L' = 0.14 M = −0.00033 M' = 0.28	h = 0.010000 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	24.3	sd	21.7	21.6	21.4	6.43
	Carbon dioxide	%	0.72	sd	0.71	0.71	0.70	3321.46
	Oxides of nitrogen	ppm	11.4	sd	11.5	11.4	11.3	5.60
	Nitric oxide	ppm			11.2	11.1	11.0	5.42
	Nitrogen dioxide	ppm			0.4	0.4	0.4	0.18
	Hydrocarbons, $CH_{y/x}$	ppmC	2.0	w	2.0	2.0	2.0	0.30
	Hydrocarbons, CH_4							0.34
	Oxygen	%			20.02	19.90	19.70	
	Nitrogen	%			79.26	78.78	78.00	
	Water	%					1.59	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 163
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9841
F/A = 0.003257
Combustion efficiency = 99.82%
Thrust = 5933 pounds
Engine speed = 6662 rpm
Engine exhaust temperature = 835°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4545 pounds per hour

Carbon monoxide	29.23
Carbon dioxide	15096.06
Oxides of nitrogen	25.45
Hydrocarbons, $CH_{y/x}$	1.35
Hydrocarbons, CH_4	1.57
Sulfur dioxide	1.82

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 MAY 1977
Engine S/N 401917
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-8D	90% NORMAL RATED	File J79001D

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	h = 0.010000 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	16.8	sd	13.9	13.9	13.7	3.06
	Carbon dioxide	%	0.96	sd	0 95	0.95	0.94	3289.04
	Oxides of nitrogen	ppm	23.2	sd	23.4	23.3	23.0	8.46
	Nitric oxide	ppm			22.7	22.6	22.3	8.20
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.27
	Hydrocarbons, $CH_{y/x}$	ppmC	1.0	w	1.0	1.0	1.0	0.11
	Hydrocarbons, CH_4							0.13
	Oxygen	%			19.70	19.58	19.34	
	Nitrogen	%			79.35	78.87	77.92	
	Water	%					1.80	

D	Sulfur dioxide, calc.	0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	257
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9820
F/A = 0.004382
Combustion efficiency = 99.92%
Thrust = 9700 pounds
Engine speed = 7155 rpm
Engine exhaust temperature = 1111°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 8206 pounds per hour

Carbon monoxide	25.15
Carbon dioxide	26989.87
Oxides of nitrogen	69.45
Hydrocarbons, $CH_{y/x}$	0.91
Hydrocarbons, CH_4	1.05
Sulfur dioxide	3.28

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 MAY 1977
Engine S/N 401917
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79–GE–8D	MILITARY	File J79001M

B			
	J = –0.07 L = –0.0001 L′ = 0.14 M = –0.00033 M′ = 0.28	h = 0.010000 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	13.5	sd	10.5	10.5	10.3	2.07
	Carbon dioxide	%	1.07	sd	1.06	1.06	1.04	3278.84
	Oxides of nitrogen	ppm	32.0	sd	32.3	32.2	31.7	10.44
	Nitric oxide	ppm			31.3	31.1	30.7	10.11
	Nitrogen dioxide	ppm			1.0	1.0	1.0	0.33
	Hydrocarbons, $CH_{y/x}$	ppmC	1.4	w	1.4	1.4	1.4	0.14
	Hydrocarbons, CH_4							0.16
	Oxygen	%			19.55	19.43	19.18	
	Nitrogen	%			79.38	78.91	77.88	
	Water	%					1.90	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 322
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9810
F/A = 0.004898
Combustion efficiency = 99.94%
Thrust = 10838 pounds
Engine speed = 7690 rpm
Engine exhaust temperature = 1160°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 9453 pounds per hour

Carbon monoxide	19.54
Carbon dioxide	30994.88
Oxides of nitrogen	98.70
Hydrocarbons, $CH_{y/x}$	1.31
Hydrocarbons, CH_4	1.52
Sulfur dioxide	3.78

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 MAY 1977
Engine S/N 401917
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-10	AFTERBURNER	File J79020A

B			
	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00209 M' = 0.28	T = 63°F RH = 72% B = 29.92 in. Hg h = 0.013935 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	281.3	sd	247.6	246.1	236.2	13.25
	Carbon dioxide	%	3.81	sd	3.79	3.77	3.62	3186.92
	Oxides of nitrogen	ppm	52.9	sd	53.7	53.4	51.2	4.72
	Nitric oxide	ppm			52.0	51.7	49.6	4.57
	Nitrogen dioxide	ppm			1.7	1.7	1.6	0.15
	Hydrocarbons, $CH_{y/x}$	ppmC	32.7	w	34.3	34.1	32.7	0.91
	Hydrocarbons, CH_4							1.05
	Oxygen	%	15.7	sd	15.83	15.73	15.10	
	Nitrogen	%			80.35	79.87	76.66	
	Water	%					4.60	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 157
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 156

F

K = 0.9540
F/A = 0.017773
Combustion efficiency = 99.60%
Thrust = 17222 pounds
Engine speed = 7464 rpm
Engine exhaust temperature = 1281°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 34315 pounds per hour

Carbon monoxide	454.56
Carbon dioxide	109359.20
Oxides of nitrogen	161.87
Hydrocarbons, $CH_{y/x}$	31.06
Hydrocarbons, CH_4	36.05
Sulfur dioxide	13.73

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 12 JUNE 1974
Engine S/N 433996
Test Cell 20, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-10B	IDLE	File J79BB01I

B			
	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00161 M' = 0.28	T = 61°F RH = 72% B = 29.88 in. Hg H = 0.012991 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	415.6	sd	402.1	399.7	394.5	111.41
Carbon dioxide	%	0.70	sd	0.69	0.69	0.68	3023.18
Oxides of nitrogen	ppm	2.9	sd	2.9	2.9	2.9	1.33
Nitric oxide	ppm			2.8	2.8	2.8	1.29
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.04
Hydrocarbons, $CH_{y/x}$	ppmC	281.1	w	286.5	284.8	281.1	39.19
Hydrocarbons, CH_4							45.47
Oxygen	%	20.0	sd	20.01	19.89	19.63	
Nitrogen	%			79.25	78.77	77.75	
Water	%					1.90	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 39
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 44

F

K = 0.9810
F/A = 0.003480
Combustion efficiency = 93.50%
Thrust = 265 pounds
Engine speed = 5077 rpm
Engine exhaust temperature = 622°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1250 pounds per hour

Carbon monoxide	139.26
Carbon dioxide	3778.97
Oxides of nitrogen	1.67
Hydrocarbons, $CH_{y/x}$	48.98
Hydrocarbons, CH_4	56.84
Sulfur dioxide	0.50

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 12 June 1974
Engine S/N 433421
Test Cell 19, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-10B	30% THRUST	File J79BB01B

B	$J = -0.07$ $L = -0.0009$ $L' = 0.14$ $M = -0.00161$ $M' = 0.28$	$T = 61°F$ $RH = 72\%$ $B = 29.88$ in. Hg $H = 0.012991$ $h_{sd} = 0.00607$	$m = 13.0$ $n = 23.4$ $\eta = 0.95$

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	67.9	sd	53.5	53.1	52.5	20.04
	Carbon dioxide	%	0.57	sd	0.57	0.56	0.56	3331.43
	Oxides of nitrogen	ppm	6.8	sd	6.9	6.8	6.7	4.23
	Nitric oxide	ppm			6.7	6.6	6.5	4.10
	Nitrogen dioxide	ppm			0.2	0.2	0.2	0.13
	Hydrocarbons, $CH_{y/x}$	ppmC	15.6	w	15.9	15.8	15.6	2.94
	Hydrocarbons, CH_4							3.41
	Oxygen	%	20.2	sd	20.22	20.10	19.86	
	Nitrogen	%			79.21	78.73	77.82	
	Water	%					1.76	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 112
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 121

F

K = 0.9824
F/A = 0.002573
Combustion efficiency = 99.24%
Thrust = 3381 pounds
Engine speed = 6340 rpm
Engine exhaust temperature = 682°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 3422 pounds per hour

Carbon monoxide	68.59
Carbon dioxide	11400.14
Oxides of nitrogen	14.48
Hydrocarbons, $CH_{y/x}$	10.06
Hydrocarbons, CH_4	11.67
Sulfur dioxide	1.37

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 12 June 1974
Engine S/N 433421
Test Cell 19, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-10B	85% RPM	File J79BB01C

B			
	J = −0.07 L = −0.0009 L′ = 0.14 M = −0.00161 M′ = 0.28	T = 61°F RH = 72% B = 29.88 in. Hg H = 0.012991 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	57.6	sd	42.3	42.0	41.5	13.63
Carbon dioxide	%	0.66	sd	0.65	0.65	0.64	3317.03
Oxides of nitrogen	ppm	8.6	sd	8.7	8.6	8.5	4.60
Nitric oxide	ppm			8.4	8.4	8.3	4.46
Nitrogen dioxide	ppm			0.3	0.3	0.3	0.15
Hydrocarbons, $CH_{y/x}$	ppmC	14.3	w	14.6	14.5	14.3	2.32
Hydrocarbons, CH_4							2.69
Oxygen	%	20.1	sd	20.10	19.98	19.73	
Nitrogen	%			79.24	78.76	77.79	
Water	%					1.83	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 126
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 142

F

K = 0.9817
F/A = 0.002991
Combustion efficiency = 99.45%
Thrust = 4243 pounds
Engine speed = 6496 rpm
Engine exhaust temperature = 735°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 3640 pounds per hour

Carbon monoxide	49.63
Carbon dioxide	12074.00
Oxides of nitrogen	16.75
Hydrocarbons, $CH_{y/x}$	8.44
Hydrocarbons, CH_4	9.79
Sulfur dioxide	1.46

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 12 June 1974
Engine S/N 433421
Test Cell 19, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-10B	75% THRUST	File J79BB01D

B	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00161 M' = 0.28	T = 61°F RH = 72% B = 29.88 in. Hg H = 0.012991 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
C	Carbon monoxide	ppm	31.3	sd	12.9	12.8	12.6	2.74
	Carbon dioxide	%	0.99	sd	0.98	0.98	0.96	3281.22
	Oxides of nitrogen	ppm	23.4	sd	23.7	23.5	23.2	8.26
	Nitric oxide	ppm			22.9	22.8	22.4	8.00
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.26
	Hydrocarbons, $CH_{y/x}$	ppmC	14.9	w	15.2	15.1	14.9	1.60
	Hydrocarbons, CH_4							1.85
	Oxygen	%	19.7	sd	19.66	19.54	19.24	
	Nitrogen	%			79.36	78.88	77.68	
	Water	%					2.12	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 243
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 270

F
K = 0.9788
F/A = 0.004530
Combustion efficiency = 99.78%
Thrust = 9000 pounds
Engine speed = 7171 rpm
Engine exhaust temperature = 1080°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7578 pounds per hour

Carbon monoxide	20.74
Carbon dioxide	24865.06
Oxides of nitrogen	62.58
Hydrocarbons, $CH_{y/x}$	12.10
Hydrocarbons, CH_4	14.04
Sulfur dioxide	3.03

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 12 June 1974
Engine S/N 433421
Test Cell 19, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	**J79-GE-10B**	**INTERMEDIATE**	**File J79BB01M**

B	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00161 M' = 0.28	T = 61°F RH = 72% B = 29.88 in. Hg H = 0.012991 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	29.3	sd	9.1	9.0	8.9	1.60
	Carbon dioxide	%	1.19	sd	1.18	1.17	1.15	3265.84
	Oxides of nitrogen	ppm	35.1	sd	35.5	35.3	34.7	10.26
	Nitric oxide	ppm			34.4	34.2	33.6	9.93
	Nitrogen dioxide	ppm			1.1	1.1	1.1	0.32
	Hydrocarbons, $CH_{y/x}$	ppmC	13.6	w	13.9	13.8	13.6	1.21
	Hydrocarbons, CH_4							1.40
	Oxygen	%	19.4	sd	19.39	19.27	18.94	
	Nitrogen	%			79.43	78.95	77.61	
	Water	%					2.29	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 311
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 333

F
K = 0.9771
F/A = 0.005467
Combustion efficiency = 99.84%
Thrust = 11248 pounds
Engine speed = 7475 rpm
Engine exhaust temperature = 1286°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 10000 pounds per hour

Carbon monoxide	15.97
Carbon dioxide	32658.38
Oxides of nitrogen	102.58
Hydrocarbons, $CH_{y/x}$	12.09
Hydrocarbons, CH_4	14.03
Sulfur dioxide	4.00

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 12 June 1974
Engine S/N 433421
Test Cell 19, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-10B	AFTERBURNER	File J79BB01A

B			
	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00161 M' = 0.28	T = 61°F RH = 72% B = 29.88 in. Hg H = 0.012991 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	294.3	sd	264.2	262.6	252.5	14.56
	Carbon dioxide	%	3.70	sd	3.68	3.66	3.52	3186.88
	Oxides of nitrogen	ppm	49.1	sd	49.8	49.5	47.6	4.51
	Nitric oxide	ppm			48.2	48.0	46.1	4.37
	Nitrogen dioxide	ppm			1.6	1.6	1.5	0.14
	Hydrocarbons, $CH_{y/x}$	ppmC	18.3	w	19.1	19.0	18.3	0.52
	Hydrocarbons, CH_4							0.60
	Oxygen	%	15.7	sd	15.97	15.88	15.27	
	Nitrogen	%			80.31	79.83	76.76	
	Water	%					4.42	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 150
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 145

F

K = 0.9558
F/A = 0.017267
Combustion efficiency = 99.61%
Thrust = 17500 pounds
Engine speed = 7475 rpm
Engine exhaust temperature

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 35000 pounds per hour

Carbon monoxide	509.57
Carbon dioxide	111540.90
Oxides of nitrogen	157.78
Hydrocarbons, $CH_{y/x}$	18.23
Hydrocarbons, CH_4	21.15
Sulfur dioxide	14.00

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 12 June 1974
Engine S/N 433421
Test Cell 19, single point probe 95 feet behind engine exhaust plane.
JP-5 fuel.

A — **J79-GE-8B** **IDLE** **File J79002I**

B

$J = -0.07$	$T = 64°F$	$m = 13.0$
$L = -0.0001$	$RH = 70\%$	$n = 23.4$
$L' = 0.14$	$B = 29.91$ in. Hg	$\eta = 0.95$
$M = -0.00033$	$H = 0.014040$	
$M' = 0.28$	$h_{sd} = 0.00607$	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	166.9	sd	165.3	164.3	162.1	54.92
Carbon dioxide	%	0.62	sd	0.62	0.61	0.60	3210.91
Oxides of nitrogen	ppm	4.1	sd	4.1	4.1	4.1	2.26
Nitric oxide	ppm			4.0	4.0	3.9	2.19
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.07
Hydrocarbons, $CH_{y/x}$	ppmC	100.6	w	102.6	101.9	100.6	16.82
Hydrocarbons, CH_4							19.52
Oxygen	%			20.14	20.02	19.76	
Nitrogen	%			79.23	78.75	77.71	
Water	%					1.91	

D — Sulfur dioxide, calc. 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 61
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9809
F/A = 0.002903
Combustion efficiency = 97.04%
Thrust = 233 pounds
Engine speed = 5016 rpm
Engine exhaust temperature = 605°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1188 pounds per hour

Carbon monoxide	65.25
Carbon dioxide	3814.57
Oxides of nitrogen	2.69
Hydrocarbons, $CH_{y/x}$	19.98
Hydrocarbons, CH_4	23.19
Sulfur dioxide	0.48

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-8B	75% RPM	File J79002B

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	69.2	sd	67.1	66.7	65.9	29.41
	Carbon dioxide	%	0.49	sd	0.49	0.48	0.48	3345.65
	Oxides of nitrogen	ppm	4.2	sd	4.2	4.2	4.2	3.05
	Nitric oxide	ppm			4.1	4.1	4.0	2.96
	Nitrogen dioxide	ppm			0.1	0.1	0.1	0.10
	Hydrocarbons, $CH_{y/x}$	ppmC	17.3	w	17.6	17.5	17.3	3.81
	Hydrocarbons, CH_4							4.42
	Oxygen	%			20.33	20.20	19.96	
	Nitrogen	%			79.18	78.70	77.76	
	Water	%					1.79	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 76
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9821
F/A = 0.002203
Combustion efficiency = 98.94%
Thrust = 863 pounds
Engine speed = 5768 rpm
Engine exhaust temperature = 527°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1567 pounds per hour

Carbon monoxide	46.09
Carbon dioxide	5242.64
Oxides of nitrogen	4.78
Hydrocarbons, $CH_{y/x}$	5.97
Hydrocarbons, CH_4	6.93
Sulfur dioxide	0.63

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	**J79-GE-8B**	**87% RPM**	**File J79002C**

B

J = -0.07	T = 64°F	m = 13.0
L = -0.0001	RH = 70%	n = 23.4
L' = 0.14	B = 29.91 in. Hg	η = 0.95
M = -0.00033	h = 0.014040	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	23.4	sd	20.8	20.7	20.4	6.07
Carbon dioxide	%	0.73	sd	0.72	0.72	0.71	3319.84
Oxides of nitrogen	ppm	11.5	sd	11.6	11.5	11.4	5.57
Nitric oxide	ppm			11.3	11.2	11.0	5.39
Nitrogen dioxide	ppm			0.4	0.4	0.4	0.18
Hydrocarbons, $CH_{y/x}$	ppmC	2.2	w	2.2	2.2	2.2	0.32
Hydrocarbons, CH_4							0.38
Oxygen	%			20.01	19.89	19.61	
Nitrogen	%			79.27	78.79	77.69	
Water	%					1.99	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 153
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9801
F/A = 0.003304
Combustion efficiency = 99.83%
Thrust = 6015 pounds
Engine speed = 6600 rpm
Engine exhaust temperature = 872°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4689 pounds per hour

Carbon monoxide	28.48
Carbon dioxide	15566.75
Oxides of nitrogen	26.11
Hydrocarbons, $CH_{y/x}$	1.52
Hydrocarbons, CH_4	1.76
Sulfur dioxide	1.88

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	**J79-GE-8B**	**90% RPM**	**File J79002D**

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
C	Carbon monoxide	ppm	18.5	sd	15.6	15.6	15.3	3.40
	Carbon dioxide	%	0.97	sd	0.96	0.96	0.94	3286.69
	Oxides of nitrogen	ppm	22.3	sd	22.5	22.4	22.0	8.05
	Nitric oxide	ppm			21.8	21.7	21.3	7.79
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.25
	Hydrocarbons, $CH_{y/x}$	ppmC	2.7	w	2.8	2.7	2.7	0.30
	Hydrocarbons, CH_4							0.34
	Oxygen	%			19.68	19.57	19.25	
	Nitrogen	%			79.35	78.87	77.60	
	Water	%					2.20	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	233
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9780
F/A = 0.004431
Combustion efficiency = 99.89%
Thrust = 9659 pounds
Engine speed = 7126 rpm
Engine exhaust temperature = 1117°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 8213 pounds per hour

Carbon monoxide	27.93
Carbon dioxide	26993.62
Oxides of nitrogen	66.08
Hydrocarbons, $CH_{y/x}$	2.43
Hydrocarbons, CH_4	2.82
Sulfur dioxide	3.29

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-8B	95% RPM	File J79002E

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
C	Carbon monoxide	ppm	15.8	sd	12.9	12.8	12.6	2.69
	Carbon dioxide	%	1.01	sd	1.00	1.00	0.98	3283.97
	Oxides of nitrogen	ppm	25.4	sd	25.7	25.5	25.1	8.79
	Nitric oxide	ppm			24.9	24.7	24.3	8.52
	Nitrogen dioxide	ppm			0.8	0.8	0.8	0.28
	Hydrocarbons, $CH_{y/x}$	ppmC	1.1	w	1.1	1.1	1.1	0.12
	Hydrocarbons, CH_4							0.13
	Oxygen	%			19.63	19.51	19.19	
	Nitrogen	%			79.36	78.88	77.59	
	Water	%					2.23	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	257
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9777
F/A = 0.004617
Combustion efficiency = 99.93%
Thrust = 10291 pounds
Engine speed = 7280 rpm
Engine exhaust temperature = 1134°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 8412 pounds per hour

Carbon monoxide	22.61
Carbon dioxide	27624.79
Oxides of nitrogen	73.97
Hydrocarbons, $CH_{y/x}$	0.97
Hydrocarbons, CH_4	1.13
Sulfur dioxide	3.36

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	**J79-GE-8B**	**MILITARY**	**File J79002M**
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
C	Carbon monoxide	ppm	16.3	sd	13.3	13.2	13.0	2.59
	Carbon dioxide	%	1.08	sd	1.07	1.07	1.05	3276.97
	Oxides of nitrogen	ppm	32.9	sd	33.3	33.1	32.5	10.63
	Nitric oxide	ppm			32.2	32.0	31.5	10.29
	Nitrogen dioxide	ppm			1.0	1.0	1.0	0.34
	Hydrocarbons, $CH_{y/x}$	ppmC	1.6	w	1.6	1.6	1.6	0.16
	Hydrocarbons, CH_4							0.18
	Oxygen	%			19.54	19.42	19.09	
	Nitrogen	%			79.39	78.91	77.57	
	Water	%					2.29	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 313
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9771
F/A = 0.004946
Combustion efficiency = 99.92%
Thrust = 10939 pounds
Engine speed = 7686 rpm
Engine exhaust temperature = 1160°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 9225 pounds per hour

Carbon monoxide	23.92
Carbon dioxide	30230.07
Oxides of nitrogen	98.06
Hydrocarbons, $CH_{y/x}$	1.45
Hydrocarbons, CH_4	1.68
Sulfur dioxide	3.69

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	J79-GE-8B	75% RPM	File J79F02B

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	88.9	sd	87.0	86.4	85.4	37.86
Carbon dioxide	%	0.49	sd	0.49	0.48	0.48	3325.27
Oxides of nitrogen	ppm	3.2	sd	3.2	3.2	3.2	2.31
Nitric oxide	ppm			3.1	3.1	3.1	2.24
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.07
Hydrocarbons, $CH_{y/x}$	ppmC	25.7	w	26.2	26.0	25.7	5.62
Hydrocarbons, CH_4							6.53
Oxygen	%			20.32	20.20	19.96	
Nitrogen	%			79.18	78.70	77.76	
Water	%					1.79	

D Sulfur dioxide, calc. 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 58
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9821
F/A = 0.002216
Combustion efficiency = 98.56%
Thrust = 863 pounds
Engine speed = 5768 rpm
Engine exhaust temperature = 527°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1567 pounds per hour

Carbon monoxide	59.33
Carbon dioxide	5210.70
Oxides of nitrogen	3.62
Hydrocarbons, $CH_{y/x}$	8.81
Hydrocarbons, CH_4	10.23
Sulfur dioxide	0.63

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel with ferrocene.

A	J79-GE-8B	87% RPM	File J79F02C

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	31.5	sd	29.0	28.8	28.4	8.44
Carbon dioxide	%	0.73	sd	0.72	0.72	0.71	3315.94
Oxides of nitrogen	ppm	10.0	sd	10.1	10.0	9.9	4.84
Nitric oxide	ppm			9.8	9.7	9.6	4.68
Nitrogen dioxide	ppm			0.3	0.3	0.3	0.15
Hydrocarbons, $CH_{y/x}$	ppmC	2.2	w	2.2	2.2	2.2	0.32
Hydrocarbons, CH_4							0.37
Oxygen	%			20.01	19.89	19.61	
Nitrogen	%			79.27	78.79	77.69	
Water	%					1.99	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 133
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9801
F/A = 0.003308
Combustion efficiency = 99.77%
Thrust = 6015 pounds
Engine speed = 6600 rpm
Engine exhaust temperature = 872°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4689 pounds per hour

Carbon monoxide	39.58
Carbon dioxide	15548.46
Oxides of nitrogen	22.68
Hydrocarbons, $CH_{y/x}$	1.51
Hydrocarbons, CH_4	1.76
Sulfur dioxide	1.88

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel with ferrocene.

A	J79-GE-8B	90% RPM	File J79F02D

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	25.9	sd	23.1	23.0	22.6	5.01
Carbon dioxide	%	0.97	sd	0.96	0.96	0.94	3284.08
Oxides of nitrogen	ppm	20.8	sd	21.0	20.9	20.6	7.50
Nitric oxide	ppm			20.4	20.2	19.9	7.26
Nitrogen dioxide	ppm			0.7	0.7	0.6	0.24
Hydrocarbons, $CH_{y/x}$	ppmC	2.7	w	2.8	2.7	2.7	0.30
Hydrocarbons, CH_4							0.34
Oxygen	%			19.68	19.56	19.25	
Nitrogen	%			79.35	78.87	77.60	
Water	%					2.20	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 217
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9780
F/A = 0.004435
Combustion efficiency = 99.85%
Thrust = 9659 pounds
Engine speed = 7126 rpm
Engine exhaust temperature = 1117°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 8213 pounds per hour

Carbon monoxide	41.18
Carbon dioxide	26972.14
Oxides of nitrogen	61.58
Hydrocarbons, $CH_{y/x}$	2.43
Hydrocarbons, CH_4	2.82
Sulfur dioxide	3.29

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel with ferrocene.

A	**J79-GE-8B**	**95% RPM**	**File J79F02E**

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	19.4	sd	16.5	16.4	16.1	3.44
	Carbon dioxide	%	1.01	sd	1.00	1.00	0.98	3282.76
	Oxides of nitrogen	ppm	23.9	sd	24.2	24.0	23.6	8.27
	Nitric oxide	ppm			23.4	23.3	22.9	8.01
	Nitrogen dioxide	ppm			0.8	0.8	0.7	0.26
	Hydrocarbons, $CH_{y/x}$	ppmC	1.1	w	1.1	1.1	1.1	0.12
	Hydrocarbons, CH_4							0.13
	Oxygen	%			19.63	19.51	19.19	
	Nitrogen	%			79.36	78.88	77.59	
	Water	%					2.23	

D	Sulfur dioxide, calc.	0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	241
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9777
F/A = 0.004619
Combustion efficiency = 99.91%
Thrust = 10939 pounds
Engine speed = 7686 rpm
Engine exhaust temperature = 1160°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 8412 pounds per hour

Carbon monoxide	28.96
Carbon dioxide	27614.55
Oxides of nitrogen	69.58
Hydrocarbons, $CH_{y/x}$	0.97
Hydrocarbons, CH_4	1.13
Sulfur dioxide	3.36

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel with ferrocene.

A	J79-GE-8B	MILITARY	File J79F02M

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 64°F RH = 70% B = 29.91 in. Hg h = 0.014040 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	20.9	sd	18.0	17.8	17.5	3.49
Carbon dioxide	%	1.08	sd	1.07	1.07	1.05	3275.52
Oxides of nitrogen	ppm	30.7	sd	31.0	30.8	30.3	9.91
Nitric oxide	ppm			30.1	29.9	29.4	9.60
Nitrogen dioxide	ppm			1.0	1.0	1.0	0.31
Hydrocarbons, $CH_{y/x}$	ppmC	1.6	w	1.6	1.6	1.6	0.16
Hydrocarbons, CH_4							0.18
Oxygen	%			19.54	19.42	19.09	
Nitrogen	%			79.39	78.91	77.57	
Water	%					2.29	

D Sulfur dioxide, calc. — 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 292
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9771
F/A = 0.004949
Combustion efficiency = 99.90%
Thrust = 10939 pounds
Engine speed = 7686 rpm
Engine exhaust temperature = 1160°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 9225 pounds per hour

Carbon monoxide	32.21
Carbon dioxide	30216.70
Oxides of nitrogen	91.46
Hydrocarbons, $CH_{y/x}$	1.45
Hydrocarbons, CH_4	1.68
Sulfur dioxide	3.69

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 13 MAY 1977
Engine S/N 401394
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel with ferrocene.

A	7LM1500-PB-104A	IDLE	File LM1501I

B	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00642 M' = 0.28	T = 59°F RH = 73% B = 30.08 in. Hg h = 0.012184 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	124.1	sd	82.0	81.6	80.8	40.86
	Carbon dioxide	%	0.43	sd	0.43	0.42	0.42	3336.90
	Oxides of nitrogen	ppm	1.6	sd	1.6	1.6	1.6	1.32
	Nitric oxide	ppm			1.6	1.6	1.5	1.28
	Nitrogen dioxide	ppm			0.1	0.1	0.1	0.04
	Hydrocarbons, $CH_{y/x}$	ppmC	41.5	w	42.2	41.9	41.5	10.36
	Hydrocarbons, CH_4							12.02
	Oxygen	%			20.41	20.28	20.09	
	Nitrogen	%			79.16	78.68	77.93	
	Water	%					1.56	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 33
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9844
F/A = 0.001938
Combustion efficiency = 98.02%
Thrust = 565 pounds
Engine speed = 5026 rpm
Engine exhaust temperature = 690°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1237 pounds per hour

Carbon monoxide	50.54
Carbon dioxide	4127.74
Oxides of nitrogen	1.63
Hydrocarbons, $CH_{y/x}$	12.82
Hydrocarbons, CH_4	14.87
Sulfur dioxide	0.49

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 FEBRUARY 1975
Engine S/N 417214
Test Cell 13, single point probe 50 feet behind engine exhaust plane.
JP-5 fuel, 346 square inch nozzle.

A	7LM1500-PB-104A	75% THRUST	File LM1501B

B	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00642 M' = 0.28	T = 59°F RH = 73% B = 30.08 in. Hg h = 0.012184 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	56.4	sd	12.1	12.1	11.9	4.14
	Carbon dioxide	%	0.63	sd	0.62	0.62	0.61	3344.09
	Oxides of nitrogen	ppm	6.7	sd	6.8	6.7	6.7	3.79
	Nitric oxide	ppm			6.6	6.5	6.4	3.67
	Nitrogen dioxide	ppm			0.2	0.2	0.2	0.12
	Hydrocarbons, $CH_{y/x}$	ppmC	8.0	w	8.1	8.1	8.0	1.37
	Hydrocarbons, CH_4							1.59
	Oxygen	%			20.14	20.02	19.80	
	Nitrogen	%			79.23	78.75	77.86	
	Water	%					1.73	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 104
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9827
F/A = 0.002832
Combustion efficiency = 99.77%
Thrust = 6041 pounds
Engine speed = 6957 rpm
Engine exhaust temperature = 815°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4597 pounds per hour

Carbon monoxide	19.02
Carbon dioxide	15372.79
Oxides of nitrogen	17.40
Hydrocarbons, $CH_{y/x}$	6.29
Hydrocarbons, CH_4	7.30
Sulfur dioxide	1.84

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 FEBRUARY 1975
Engine S/N 417214
Test Cell 13, single point probe 50 feet behind engine exhaust plane.
JP-5 fuel, 346 square inch nozzle.

A	7LM1500-PB-104A	NORMAL RATED	File LM1501N

B			
	J = -0.07	T = 59°F	m = 13.0
	L = -0.0009	RH = 73%	n = 23.4
	L' = 0.14	B = 30.08 in. Hg	η = 0.95
	M = -0.00642	h = 0.012184	
	M' = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	54.7	sd	8.7	8.7	8.6	2.26
	Carbon dioxide	%	0.82	sd	0.81	0.81	0.80	3307.09
	Oxides of nitrogen	ppm	13.9	sd	14.0	14.0	13.8	5.97
	Nitric oxide	ppm			13.6	13.5	13.3	5.78
	Nitrogen dioxide	ppm			0.4	0.4	0.4	0.19
	Hydrocarbons, $CH_{y/x}$	ppmC	7.6	w	7.7	7.7	7.6	0.99
	Hydrocarbons, CH_4							1.15
	Oxygen	%			19.89	19.77	19.51	
	Nitrogen	%			79.30	78.82	77.80	
	Water	%					1.89	

D	Sulfur dioxide, calc.	0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	172
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9811
F/A = 0.003725
Combustion efficiency = 99.85%
Thrust = 10024 pounds
Engine speed = 7453 rpm
Engine exhaust temperature = 1080°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7903 pounds per hour

Carbon monoxide	17.87
Carbon dioxide	26135.91
Oxides of nitrogen	47.17
Hydrocarbons, $CH_{y/x}$	7.82
Hydrocarbons, CH_4	9.07
Sulfur dioxide	3.16

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 FEBRUARY 1975
Engine S/N 417214
Test Cell 13, single point probe 50 feet behind engine exhaust plane.
JP-5 fuel, 346 square inch nozzle.

A	7LM1500-PB-104A	INTERMEDIATE	File LM1501M

B			
	J = -0.07 L = -0.0009 L' = 0.14 M = -0.00642 M' = 0.28	T = 59°F RH = 73% B = 30.08 in. Hg h = 0.012184 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	53.2	sd	7.1	7.1	7.0	1.82
Carbon dioxide	%	0.83	sd	0.82	0.82	0.81	3306.05
Oxides of nitrogen	ppm	15.2	sd	15.4	15.3	15.1	6.45
Nitric oxide	ppm			14.9	14.8	14.6	6.24
Nitrogen dioxide	ppm			0.5	0.5	0.5	0.20
Hydrocarbons, $CH_{y/x}$	ppmC	8.0	w	8.2	8.1	8.0	1.03
Hydrocarbons, CH_4							1.19
Oxygen	%			19.87	19.75	19.50	
Nitrogen	%			79.30	78.82	77.79	
Water	%					1.90	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 186
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9810
F/A = 0.003771
Combustion efficiency = 99.85%
Thrust = 10509 pounds
Engine speed = 7564 rpm
Engine exhaust temperature = 1120°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 8356 pounds per hour

Carbon monoxide	15.25
Carbon dioxide	27625.34
Oxides of nitrogen	53.86
Hydrocarbons, $CH_{y/x}$	8.59
Hydrocarbons, CH_4	9.97
Sulfur dioxide	3.34

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 FEBRUARY 1975
Engine S/N 417214
Test Cell 13, single point probe 50 feet behind engine exhaust plane.
JP-5 fuel, 346 square inch nozzle.

A	**LM2500**	**IDLE**	**File LM2501I**

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 66°F RH = 50% B = 29.98 in. Hg h = 0.010701 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	259.1	sd	258.0	256.5	253.8	77.73
Carbon dioxide	%	0.65	sd	0.64	0.64	0.63	3051.92
Oxides of nitrogen	ppm	2.3	sd	2.3	2.3	2.3	1.15
Nitric oxide	ppm			2.3	2.2	2.2	1.11
Nitrogen dioxide	ppm			0.1	0.1	0.1	0.04
Hydrocarbons, $CH_{y/x}$	ppmC	334.8	w	340.3	338.3	334.8	50.60
Hydrocarbons, CH_4							58.72
Oxygen	%			20.09	19.97	19.77	
Nitrogen	%			79.23	78.76	77.95	
Water	%					1.62	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 35
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9838
F/A = 0.003201
Combustion efficiency = 93.14%
Engine speed = 5000 rpm
Engine exhaust temperature = 694°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 800 pounds per hour

Carbon monoxide	62.18
Carbon dioxide	2441.54
Oxides of nitrogen	0.92
Hydrocarbons, $CH_{y/x}$	40.48
Hydrocarbons, CH_4	46.97
Sulfur dioxide	0.32

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	LM2500	7235 RPM	File LM2501B

B			
	J = -0.07	T = 66°F	m = 13.0
	L = -0.0001	RH = 50%	n = 23.4
	L' = 0.14	B = 29.98 in. Hg	η = 0.95
	M = -0.00033	h = 0.010701	
	M' = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	124.7	sd	122.8	122.0	120.7	36.51
	Carbon dioxide	%	0.70	sd	0.69	0.69	0.68	3245.36
	Oxides of nitrogen	ppm	5.3	sd	5.4	5.3	5.3	2.62
	Nitric oxide	ppm			5.2	5.2	5.1	2.53
	Nitrogen dioxide	ppm			0.2	0.2	0.2	0.08
	Hydrocarbons, $CH_{y/x}$	ppmC	64.2	w	65.3	64.9	64.2	9.58
	Hydrocarbons, CH_4							11.12
	Oxygen	%			20.04	19.92	19.71	
	Nitrogen	%			79.25	78.78	77.94	
	Water	%					1.65	

D	Sulfur dioxide, calc.	0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 76
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9835
F/A = 0.003242
Combustion efficiency = 98.19%
Engine speed = 7235 rpm
Engine exhaust temperature = 728°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1745 pounds per hour

Carbon monoxide	63.72
Carbon dioxide	5663.16
Oxides of nitrogen	4.56
Hydrocarbons, $CH_{y/x}$	16.72
Hydrocarbons, CH_4	19.41
Sulfur dioxide	0.70

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	LM2500	7708 RPM	File LM2501C

B

J = -0.07	T = 66°F	m = 13.0
L = -0.0001	RH = 50%	n = 23.4
L' = 0.14	B = 29.98 in. Hg	η = 0.95
M = -0.00033	h = 0.010701	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	64.6	sd	62.2	61.8	61.1	15.96
Carbon dioxide	%	0.82	sd	0.81	0.81	0.80	3280.82
Oxides of nitrogen	ppm	10.3	sd	10.4	10.3	10.2	4.39
Nitric oxide	ppm			10.1	10.0	9.9	4.25
Nitrogen dioxide	ppm			0.3	0.3	0.3	0.14
Hydrocarbons, $CH_{y/x}$	ppmC	16.7	w	17.0	16.9	16.7	2.15
Hydrocarbons, CH_4							2.50
Oxygen	%			19.88	19.76	19.53	
Nitrogen	%			79.30	78.82	77.91	
Water	%					1.75	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 130
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9825
F/A = 0.003755
Combustion efficiency = 99.41%
Engine speed = 7708 rpm
Engine exhaust temperature = 827°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 2958 pounds per hour

Carbon monoxide	47.20
Carbon dioxide	9704.67
Oxides of nitrogen	12.98
Hydrocarbons, $CH_{y/x}$	6.37
Hydrocarbons, CH_4	7.39
Sulfur dioxide	1.18

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	LM2500	7814 RPM	File LM2501D

B			
	J = −0.07	T = 66°F	m = 13.0
	L = −0.0001	RH = 50%	n = 23.4
	L' = 0.14	B = 29.98 in. Hg	η = 0.95
	M = −0.00033	h = 0.010701	
	M' = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	47.6	sd	45.0	44.7	44.2	10.65
	Carbon dioxide	%	0.89	sd	0.88	0.88	0.87	3282.17
	Oxides of nitrogen	ppm	12.6	sd	12.7	12.7	12.5	4.95
	Nitric oxide	ppm			12.3	12.3	12.1	4.79
	Nitrogen dioxide	ppm			0.4	0.4	0.4	0.16
	Hydrocarbons, $CH_{y/x}$	ppmC	9.9	w	10.1	10.0	9.9	1.18
	Hydrocarbons, CH_4							1.37
	Oxygen	%			19.79	19.67	19.43	
	Nitrogen	%			79.32	78.84	77.89	
	Water	%					1.81	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 148
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9819
F/A = 0.004072
Combustion efficiency = 99.64%
Engine speed = 7814 rpm
Engine exhaust temperature = 855°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 3431 pounds per hour

Carbon monoxide	36.52
Carbon dioxide	11261.14
Oxides of nitrogen	16.97
Hydrocarbons, $CH_{y/x}$	4.04
Hydrocarbons, CH_4	4.69
Sulfur dioxide	1.37

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	LM2500	7949 RPM	File LM2501E

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 66°F RH = 50% B = 29.98 in. Hg h = 0.010701 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	26.9	sd	24.1	24.0	23.6	5.23
	Carbon dioxide	%	0.97	sd	0.96	0.96	0.94	3282.84
	Oxides of nitrogen	ppm	17.3	sd	17.5	17.4	17.2	6.23
	Nitric oxide	ppm			16.9	16.8	16.6	6.04
	Nitrogen dioxide	ppm			0.6	0.5	0.5	0.20
	Hydrocarbons, $CH_{y/x}$	ppmC	5.2	w	5.3	5.3	5.2	0.57
	Hydrocarbons, CH_4							0.66
	Oxygen	%			19.68	19.56	19.31	
	Nitrogen	%			79.35	78.87	77.86	
	Water	%					1.88	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 188
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9812
F/A = 0.004436
Combustion efficiency = 99.82%
Engine speed = 7949 rpm
Engine exhaust temperature = 959°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4097 pounds per hour

Carbon monoxide	21.43
Carbon dioxide	13449.79
Oxides of nitrogen	25.54
Hydrocarbons, $CH_{y/x}$	2.33
Hydrocarbons, CH_4	2.70
Sulfur dioxide	1.64

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	LM2500	8046 RPM	File LM2501F

B			
	J = -0.07 L = -0.0001 L = 0.14 M = -0.00033 M' = 0.28	T = 66°F RH = 50% B = 29.98 in. Hg h = 0.010701 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	18.3	sd	15.4	15.3	15.1	3.14
	Carbon dioxide	%	1.03	sd	1.02	1.02	1.00	3280.10
	Oxides of nitrogen	ppm	20.8	sd	21.0	20.9	20.6	7.05
	Nitric oxide	ppm			20.4	20.2	20.0	6.83
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.22
	Hydrocarbons, $CH_{y/x}$	ppmC	4.2	w	4.3	4.3	4.2	0.43
	Hydrocarbons, CH_4							0.50
	Oxygen	%			19.60	19.49	19.23	
	Nitrogen	%			79.37	78.89	77.84	
	Water	%					1.93	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 215
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9807
F/A = 0.004714
Combustion efficiency = 99.88%
Engine speed = 8046 rpm
Engine exhaust temperature = 1020°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 4621 pounds per hour

Carbon monoxide	14.52
Carbon dioxide	15157.32
Oxides of nitrogen	32.59
Hydrocarbons, $CH_{y/x}$	2.00
Hydrocarbons, CH_4	2.32
Sulfur dioxide	1.85

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	LM2500	8190 RPM	File LM2501G
B	J = -0.07 L = -0.0001 L′ = 0.14 M = -0.00033 M′ = 0.28	T = 66°F RH = 50% B = 29.98 in. Hg h = 0.010701 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	9.9	sd	6.8	6.8	6.7	1.23
	Carbon dioxide	%	1.16	sd	1.15	1.14	1.13	3271.41
	Oxides of nitrogen	ppm	29.1	sd	29.4	29.2	28.8	8.74
	Nitric oxide	ppm			28.5	28.3	27.9	8.46
	Nitrogen dioxide	ppm			0.9	0.9	0.9	0.28
	Hydrocarbons, $CH_{y/x}$	ppmC	4.5	w	4.6	4.6	4.5	0.41
	Hydrocarbons, CH_4							0.48
	Oxygen	%			19.43	19.31	19.03	
	Nitrogen	%			79.42	78.94	77.80	
	Water	%					2.04	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 270
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9796
F/A = 0.005320
Combustion efficiency = 99.93%
Engine speed = 8190 rpm
Engine exhaust temperature = 1120°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 5647 pounds per hour

Carbon monoxide	6.95
Carbon dioxide	18473.62
Oxides of nitrogen	49.35
Hydrocarbons, $CH_{y/x}$	2.32
Hydrocarbons, CH_4	2.69
Sulfur dioxide	2.26

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	**LM2500**	**8210 RPM**	**File LM2501H**

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 66°F RH = 50% B = 29.98 in. Hg h = 0.010701 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	9.3	sd	6.2	6.2	6.1	1.11
	Carbon dioxide	%	1.17	sd	1.16	1.15	1.14	3270.93
	Oxides of nitrogen	ppm	29.8	sd	30.1	29.9	29.5	8.87
	Nitric oxide	ppm			29.2	29.0	28.6	8.59
	Nitrogen dioxide	ppm			0.9	0.9	0.9	0.28
	Hydrocarbons, $CH_{y/x}$	ppmC	4.1	w	4.2	4.2	4.1	0.37
	Hydrocarbons, CH_4							0.43
	Oxygen	%			19.42	19.30	19.02	
	Nitrogen	%			79.42	78.94	77.79	
	Water	%					2.05	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	274
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9795
F/A = 0.005367
Combustion efficiency = 99.94%
Engine speed = 8210 rpm
Engine exhaust temperature = 1132°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 5710 pounds per hour

Carbon monoxide	6.34
Carbon dioxide	18677.01
Oxides of nitrogen	50.66
Hydrocarbons, $CH_{y/x}$	2.11
Hydrocarbons, CH_4	2.45
Sulfur dioxide	2.28

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	**LM2500**	**8297 RPM**	**File LM2501J**
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 66°F RH = 50% B = 29.98 in. Hg h = 0.010701 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	6.8	sd	3.6	3.6	3.5	0.60
	Carbon dioxide	%	1.25	sd	1.24	1.23	1.21	3265.79
	Oxides of nitrogen	ppm	35.6	sd	36.0	35.8	35.2	9.90
	Nitric oxide	ppm			34.9	34.6	34.1	9.59
	Nitrogen dioxide	ppm			1.1	1.1	1.1	0.31
	Hydrocarbons, $CH_{y/x}$	ppmC	4.5	w	4.6	4.6	4.5	0.38
	Hydrocarbons, CH_4							0.44
	Oxygen	%			19.31	19.19	18.90	
	Nitrogen	%			79.45	78.97	77.77	
	Water	%					2.12	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 309
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9788
F/A = 0.005741
Combustion efficiency = 99.95%
Engine speed = 8297 rpm
Engine exhaust temperature = 1190°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 6385 pounds per hour

Carbon monoxide	3.85
Carbon dioxide	20852.07
Oxides of nitrogen	63.24
Hydrocarbons, $CH_{y/x}$	2.43
Hydrocarbons, CH_4	2.82
Sulfur dioxide	2.55

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	LM2500	8415 RPM	File LM2501K

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 66°F RH = 50% B = 29.98 in. Hg h = 0.010701 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	5.1	sd	1.8	1.8	1.8	0.28
	Carbon dioxide	%	1.33	sd	1.32	1.31	1.29	3260.89
	Oxides of nitrogen	ppm	45.4	sd	45.9	45.6	44.9	11.85
	Nitric oxide	ppm			44.5	44.2	43.5	11.48
	Nitrogen dioxide	ppm			1.4	1.4	1.4	0.37
	Hydrocarbons, $CH_{y/x}$	ppmC	5.6	w	5.7	5.7	5.6	0.44
	Hydrocarbons, CH_4							0.52
	Oxygen	%			19.20	19.08	18.78	
	Nitrogen	%			79.48	79.00	77.74	
	Water	%					2.19	

D	Sulfur dioxide, calc.	0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	372
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9781
F/A = 0.006116
Combustion efficiency = 99.95%
Engine speed = 8415 rpm
Engine exhaust temperature = 1269°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 7470 pounds per hour

Carbon monoxide	2.12
Carbon dioxide	24358.85
Oxides of nitrogen	88.55
Hydrocarbons, $CH_{y/x}$	3.32
Hydrocarbons, CH_4	3.85
Sulfur dioxide	2.99

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	LM2500	8643 RPM	File LM2501L

B			
	J = -0.07	T = 66°F	m = 13.0
	L = -0.0001	RH = 50%	n = 23.4
	L' = 0.14	B = 29.98 in. Hg	η = 0.95
	M = -0.00033	h = 0.010701	
	M' = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	5.3	sd	1.8	1.8	1.8	0.25
	Carbon dioxide	%	1.52	sd	1.51	1.50	1.47	3250.35
	Oxides of nitrogen	ppm	63.7	sd	64.4	64.0	62.9	14.51
	Nitric oxide	ppm			62.4	62.0	60.9	14.05
	Nitrogen dioxide	ppm			2.0	2.0	2.0	0.46
	Hydrocarbons, $CH_{y/x}$	ppmC	8.6	w	8.8	8.8	8.6	0.60
	Hydrocarbons, CH_4							0.69
	Oxygen	%			18.94	18.83	18.50	
	Nitrogen	%			79.54	79.06	77.67	
	Water	%					2.35	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 461
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9765
F/A = 0.007008
Combustion efficiency = 99.93%
Engine speed = 8643 rpm
Engine exhaust temperature = 1386°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 9130 pounds per hour

Carbon monoxide	2.28
Carbon dioxide	29675.70
Oxides of nitrogen	132.45
Hydrocarbons, $CH_{y/x}$	5.44
Hydrocarbons, CH_4	6.31
Sulfur dioxide	3.65

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	**LM2500**	**8752 RPM**	**File LM2501N**

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 66°F RH = 50% B = 29.98 in. Hg h = 0.010701 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	4.5	sd	1.0	0.9	0.9	0.13
	Carbon dioxide	%	1.58	sd	1.57	1.56	1.53	3248.31
	Oxides of nitrogen	ppm	73.0	sd	73.8	73.4	72.1	15.98
	Nitric oxide	ppm			71.5	71.1	69.8	15.48
	Nitrogen dioxide	ppm			2.3	2.3	2.3	0.50
	Hydrocarbons, $CH_{y/x}$	ppmC	6.9	w	7.1	7.0	6.9	0.46
	Hydrocarbons, CH_4							0.53
	Oxygen	%			18.86	18.75	18.41	
	Nitrogen	%			79.56	79.08	77.65	
	Water	%					2.40	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 509
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9760
F/A = 0.007287
Combustion efficiency = 99.95%
Engine speed = 8752 rpm
Engine exhaust temperature = 1440°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 10080 pounds per hour

Carbon monoxide	1.27
Carbon dioxide	32743.01
Oxides of nitrogen	161.12
Hydrocarbons, $CH_{y/x}$	4.64
Hydrocarbons, CH_4	5.38
Sulfur dioxide	4.03

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 19 MAY 1977
Engine S/N GG018
Test Cell 20, single point probe 85 feet behind engine exhaust plane.
JP-5 fuel.

A	T53-L-11D	GROUND IDLE	File T53001I

B			
	J = −0.07 L = −0.0006 L' = 0.14 M = −0.00626 M' = 0.28	T = 78°F RH = 46% B = 29.83 in. Hg h = 0.015005 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	572.0	sd	518.7	515.6	497.1	31.51
Carbon dioxide	%	3.14	sd	3.12	3.10	2.99	2979.79
Oxides of nitrogen	ppm	15.6	sd	15.8	15.7	15.2	1.58
Nitric oxide	ppm			15.3	15.2	14.7	1.53
Nitrogen dioxide	ppm			0.5	0.5	0.5	0.05
Hydrocarbons, $CH_{y/x}$	ppmC	1856.9	w	1937.7	1926.0	1856.9	58.09
Hydrocarbons, CH_4							67.41
Oxygen	%			16.71	16.60	16.01	
Nitrogen	%			80.10	79.62	76.77	
Water	%					4.17	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 55
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9583
F/A = 0.015705
Combustion efficiency = 93.46%
Shaft horsepower = 35
Engine speed = 42 percent rpm
Engine exhaust temperature = 922°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 145 pounds per hour

Carbon monoxide	4.57
Carbon dioxide	432.07
Oxides of nitrogen	0.23
Hydrocarbons, $CH_{y/x}$	8.42
Hydrocarbons, CH_4	9.77
Sulfur dioxide	0.06

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 26 AUGUST 1975
Engine S/N L-E 12771
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	T53-L-11D	FLIGHT IDLE	File T53001B

B			
	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00626 M' = 0.28	T = 78°F RH = 46% B = 29.83 in. Hg h = 0.015005 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	542.0	sd	491.8	488.8	473.5	37.79
	Carbon dioxide	%	2.60	sd	2.58	2.57	2.49	3119.75
	Oxides of nitrogen	ppm	19.8	sd	20.1	19.9	19.3	2.53
	Nitric oxide	ppm			19.4	19.3	18.7	2.45
	Nitrogen dioxide	ppm			0.6	0.6	0.6	0.08
	Hydrocarbons, $CH_{y/x}$	ppmC	344.6	w	357.9	355.7	344.6	13.57
	Hydrocarbons, CH_4							15.75
	Oxygen	%			17.44	17.33	16.79	
	Nitrogen	%			79.92	79.44	76.95	
	Water	%					3.72	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 83
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9628
F/A = 0.012443
Combustion efficiency = 97.77%
Shaft horsepower = 110
Engine speed = 62 percent rpm
Engine exhaust temperature = 892°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 222 pounds per hour

Carbon monoxide	8.39
Carbon dioxide	692.58
Oxides of nitrogen	0.56
Hydrocarbons, $CH_{y/x}$	3.01
Hydrocarbons, CH_4	3.50
Sulfur dioxide	0.09

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 26 AUGUST 1975
Engine S/N L-E 12771
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	T53-L-11D	NORMAL RATED	File T53001N

B

J = -0.07	T = 78°F	m = 13.0
L = -0.0006	RH = 46%	n = 23.4
L' = 0.14	B = 29.83 in. Hg	η = 0.95
M = -0.00626	h = 0.015005	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	186.0	sd	126.5	125.7	120.6	6.83
Carbon dioxide	%	3.79	sd	3.77	3.75	3.59	3198.31
Oxides of nitrogen	ppm	71.5	sd	72.5	72.1	69.2	6.43
Nitric oxide	ppm			70.3	69.8	67.0	6.23
Nitrogen dioxide	ppm			2.3	2.3	2.2	0.20
Hydrocarbons, $CH_{y/x}$	ppmC	20.4	w	21.4	21.3	20.4	0.57
Hydrocarbons, CH_4							0.66
Oxygen	%			15.86	15.77	15.12	
Nitrogen	%			80.35	79.86	76.59	
Water	%					4.67	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	213
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9533
F/A = 0.017618
Combustion efficiency = 99.78%
Shaft horsepower = 410
Engine speed = 95 percent rpm
Engine exhaust temperature = 1046°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 645 pounds per hour

Carbon monoxide	4.40
Carbon dioxide	2062.91
Oxides of nitrogen	4.15
Hydrocarbons, $CH_{y/x}$	0.37
Hydrocarbons, CH_4	0.43
Sulfur dioxide	0.26

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 26 AUGUST 1975
Engine S/N L-E 12771
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	T53-L-11D	MILITARY	File T53001M
B	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00626 M' = 0.28	T = 78°F RH = 46% B = 29.83 in. Hg h = 0.015005 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	133.0	sd	70.1	69.7	66.6	3.34
	Carbon dioxide	%	4.30	sd	4.28	4.25	4.06	3201.57
	Oxides of nitrogen	ppm	79.9	sd	81.1	80.6	77.0	6.34
	Nitric oxide	ppm			78.6	78.1	74.6	6.14
	Nitrogen dioxide	ppm			2.6	2.5	2.4	0.20
	Hydrocarbons, $CH_{y/x}$	ppmC	10.6	w	11.2	11.1	10.6	0.26
	Hydrocarbons, CH_4							0.30
	Oxygen	%			15.18	15.09	14.41	
	Nitrogen	%			80.53	80.04	76.43	
	Water	%					5.09	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 211
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9491
F/A = 0.019933
Combustion efficiency = 99.90%
Shaft horsepower = 569
Engine speed = 98 percent rpm
Engine exhaust temperature = 1054°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 685 pounds per hour

Carbon monoxide	2.29
Carbon dioxide	2193.08
Oxides of nitrogen	4.35
Hydrocarbons, $CH_{y/x}$	0.18
Hydrocarbons, CH_4	0.21
Sulfur dioxide	0.27

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 26 AUGUST 1975
Engine S/N L-E 12771
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	T53-L-11D	TAKEOFF	File T53001T

B			
	J = −0.07 L = −0.0006 L′ = 0.14 M = −0.00626 M′ = 0.28	T = 78°F RH = 46% B = 29.83 in. Hg h = 0.015005 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	142.0	sd	79.6	79.1	75.6	3.85
	Carbon dioxide	%	4.23	sd	4.21	4.19	4.00	3201.13
	Oxides of nitrogen	ppm	96.1	sd	97.6	97.0	92.7	7.75
	Nitric oxide	ppm			94.5	93.9	89.7	7.51
	Nitrogen dioxide	ppm			3.1	3.1	2.9	0.24
	Hydrocarbons, $CH_{y/x}$	ppmC	10.8	w	11.4	11.3	10.8	0.27
	Hydrocarbons, CH_4							0.32
	Oxygen	%			15.27	15.18	14.50	
	Nitrogen	%			80.50	80.01	76.45	
	Water	%					5.03	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 258
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9497
F/A = 0.019616
Combustion efficiency = 99.88%
Shaft horsepower = 600
Engine speed = 100 percent rpm
Engine exhaust temperature = 1075°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 690 pounds per hour

Carbon monoxide	2.66
Carbon dioxide	2208.78
Oxides of nitrogen	5.35
Hydrocarbons, $CH_{y/x}$	0.19
Hydrocarbons, CH_4	0.22
Sulfur dioxide	0.28

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 26 AUGUST 1975
Engine S/N L-E 12771
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	T56-A-16	LOW SPEED GROUND IDLE	File T56001I

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 97°F RH = 15% B = 29.95 in. Hg h = 0.008858 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	206.4	sd	204.3	203.1	200.1	30.11
Carbon dioxide	%	1.37	sd	1.36	1.35	1.33	3149.25
Oxides of nitrogen	ppm	14.4	sd	14.6	14.5	14.3	3.53
Nitric oxide	ppm			14.1	14.0	13.8	3.41
Nitrogen dioxide	ppm			0.5	0.5	0.4	0.11
Hydrocarbons, $CH_{y/x}$	ppmC	259.0	w	264.5	262.9	259.0	19.24
Hydrocarbons, CH_4							22.32
Oxygen	%	19.1	sd	19.13	19.01	18.73	
Nitrogen	%			79.49	79.01	77.85	
Water	%					2.06	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	116
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	120

F

K = 0.9794
F/A = 0.006523
Combustion efficiency = 97.38%
Shaft horsepower = 130
Engine speed = 9964 rpm
Engine exhaust temperature = 1220°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 599 pounds per hour

Carbon monoxide	18.04
Carbon dioxide	1886.40
Oxides of nitrogen	2.11
Hydrocarbons, $CH_{y/x}$	11.52
Hydrocarbons, CH_4	13.37
Sulfur dioxide	0.24

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 23 JUNE 1976
Engine S/N 102138
Test Cell 11, single point probe in test cell exhaust stack.
JP-5 fuel.

A	**T56-A-16**	**HIGH SPEED GROUND IDLE**	**File T56001B**
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 97°F RH = 15% B = 29.94 in. Hg h = 0.008860 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	30.0	sd	27.2	27.0	26.7	5.65
	Carbon dioxide	%	1.01	sd	1.00	1.00	0.98	3275.53
	Oxides of nitrogen	ppm	18.4	sd	18.6	18.5	18.3	6.35
	Nitric oxide	ppm			18.0	17.9	17.7	6.15
	Nitrogen dioxide	ppm			0.6	0.6	0.6	0.20
	Hydrocarbons, $CH_{y/x}$	ppmC	11.7	w	11.9	11.8	11.7	1.22
	Hydrocarbons, CH_4							1.42
	Oxygen	%	19.5	sd	19.63	19.51	19.29	
	Nitrogen	%			79.36	78.89	77.99	
	Water	%					1.73	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	198
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	196

F

K = 0.9827
F/A = 0.004629
Combustion efficiency = 99.75%
Shaft horsepower = 245
Engine speed = 13485 rpm
Engine exhaust temperature = 1098°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 756 pounds per hour

Carbon monoxide	4.27
Carbon dioxide	2476.30
Oxides of nitrogen	4.80
Hydrocarbons, $CH_{y/x}$	0.92
Hydrocarbons, CH_4	1.07
Sulfur dioxide	0.30

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 23 JUNE 1976
Engine S/N 102138
Test Cell 11, single point probe in test cell exhaust stack.
JP-5 fuel.

A	T56-A-16	FLIGHT IDLE	File T56001C

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 97°F RH = 15% B = 29.93 in. Hg h = 0.008863 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	27.0	sd	24.1	23.9	23.6	4.54
	Carbon dioxide	%	1.11	sd	1.10	1.09	1.08	3268.50
	Oxides of nitrogen	ppm	20.8	sd	21.0	20.9	20.6	6.52
	Nitric oxide	ppm			20.4	20.2	20.0	6.32
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.21
	Hydrocarbons, $CH_{y/x}$	ppmC	10.0	w	10.2	10.1	10.0	0.95
	Hydrocarbons, CH_4							1.10
	Oxygen	%	19.4	sd	19.49	19.38	19.14	
	Nitrogen	%			79.40	78.92	77.95	
	Water	%					1.82	

D	Sulfur dioxide, calc.	0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	205
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	207

F

K = 0.9818
F/A = 0.005096
Combustion efficiency = 99.80%
Shaft horsepower = 510
Engine speed = 13380 rpm
Engine exhaust temperature = 1155°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 836 pounds per hour

Carbon monoxide	3.80
Carbon dioxide	2732.46
Oxides of nitrogen	5.45
Hydrocarbons, $CH_{y/x}$	0.79
Hydrocarbons, CH_4	0.92
Sulfur dioxide	0.33

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 23 JUNE 1976
Engine S/N 102138
Test Cell 11, single point probe in test cell exhaust stack.
JP-5 fuel.

A	T56-A-16	75%	File T56001D

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 97°F RH = 15% B = 29.86 in. Hg h = 0.008884 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	8.2	sd	4.2	4.2	4.1	0.42
	Carbon dioxide	%	2.07	sd	2.06	2.04	2.00	3232.84
	Oxides of nitrogen	ppm	59.7	sd	60.4	60.1	58.8	9.93
	Nitric oxide	ppm			58.5	58.2	57.0	9.62
	Nitrogen dioxide	ppm			1.9	1.9	1.9	0.31
	Hydrocarbons, $CH_{y/x}$	ppmC	3.3	w	3.4	3.4	3.3	0.17
	Hydrocarbons, CH_4							0.19
	Oxygen	%	18.0	sd	18.20	18.09	17.72	
	Nitrogen	%			79.74	79.26	77.63	
	Water	%					2.65	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 327
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 318

F

K = 0.9735
F/A = 0.009577
Combustion efficiency = 99.97%
Shaft horsepower = 3550
Engine speed = 13820 rpm
Engine exhaust temperature = 1850°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1996 pounds per hour

Carbon monoxide	0.84
Carbon dioxide	6452.74
Oxides of nitrogen	19.82
Hydrocarbons, $CH_{y/x}$	0.33
Hydrocarbons, CH_4	0.39
Sulfur dioxide	0.80

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 23 JUNE 1976
Engine S/N 102138
Test Cell 11, single point probe in test cell exhaust stack.
JP-5 fuel.

A	T56-A-16	100%	File T56001E

B			
	J = −0.07 L = −0.0001 L′ = 0.14 M = −0.00033 M′ = 0.28	T = 97°F RH = 15% B = 29.85 in. Hg h = 0.008887 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	11.1	sd	7.0	7.0	6.8	0.68
	Carbon dioxide	%	2.14	sd	2.13	2.11	2.07	3230.89
	Oxides of nitrogen	ppm	64.0	sd	64.8	64.4	63.0	10.29
	Nitric oxide	ppm			62.7	62.4	61.0	9.97
	Nitrogen dioxide	ppm			2.0	2.0	2.0	0.32
	Hydrocarbons, $CH_{y/x}$	ppmC	2.5	w	2.6	2.6	2.5	0.12
	Hydrocarbons, CH_4							0.14
	Oxygen	%	17.9	sd	18.11	18.00	17.62	
	Nitrogen	%			79.76	79.28	77.60	
	Water	%					2.71	

D	Sulfur dioxide, calc.	0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	340
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	330

F

K = 0.9729
F/A = 0.009904
Combustion efficiency = 99.97%
Shaft horsepower = 3890
Engine speed = 13820 rpm
Engine exhaust temperature = 1920°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 2136 pounds per hour

Carbon monoxide	1.45
Carbon dioxide	6901.18
Oxides of nitrogen	21.99
Hydrocarbons, $CH_{y/x}$	0.26
Hydrocarbons, CH_4	0.30
Sulfur dioxide	0.85

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 23 JUNE 1976
Engine S/N 102138
Test Cell 11, single point probe in test cell exhaust stack.
JP-5 fuel.

A	T56-A-16	MILITARY	File T56001M
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 97°F RH = 15% B = 29.86 in. Hg h = 0.008884 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	11.1	sd	7.0	6.9	6.8	0.65
	Carbon dioxide	%	2.21	sd	2.20	2.18	2.13	3229.31
	Oxides of nitrogen	ppm	67.1	sd	67.9	67.5	66.1	10.45
	Nitric oxide	ppm			65.8	65.4	64.0	10.12
	Nitrogen dioxide	ppm			2.1	2.1	2.1	0.33
	Hydrocarbons, $CH_{y/x}$	ppmC	2.9	w	3.0	3.0	2.9	0.14
	Hydrocarbons, CH_4							0.16
	Oxygen	%	17.6	sd	18.01	17.90	17.51	
	Nitrogen	%			79.79	79.30	77.58	
	Water	%					2.77	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 345
Oxides of nitrogen at 3% oxygen, meas.(ppm wet) 318

F

K = 0.9723
F/A = 0.010231
Combustion efficiency = 99.97%
Shaft horsepower = 4090
Engine speed = 13820 rpm
Engine exhaust temperature = 1970°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 2219 pounds per hour

Carbon monoxide	1.45
Carbon dioxide	7165.85
Oxides of nitrogen	23.18
Hydrocarbons, $CH_{y/x}$	0.31
Hydrocarbons, CH_4	0.35
Sulfur dioxide	0.89

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 23 JUNE 1976
Engine S/N 102138
Test Cell 11, single point probe in test cell exhaust stack.
JP-5 fuel.

A	T58-GE-8F	IDLE	File T58A651
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	DEW = 56°F B = 29.81 in. Hg h = 0.015195 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	1100.9	sd	1104.6	1097.9	1077.5	178.44
	Carbon dioxide	%	1.02	sd	1.01	1.01	0.99	2569.31
	Oxides of nitrogen	ppm	5.2	w	5.4	5.4	5.3	1.43
	Nitric oxide	ppm			5.2	5.2	5.1	1.38
	Nitrogen dioxide	ppm			0.2	0.2	0.2	0.05
	Hydrocarbons, $CH_{y/x}$	ppmC	1595.6	w	1635.6	1625.7	1595.6	130.42
	Hydrocarbons, CH_4							151.34
	Oxygen	%			19.51	19.39	19.03	
	Nitrogen	%			79.35	78.88	77.41	
	Water	%					2.45	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 49
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9755
F/A = 0.005961
Combustion efficiency = 82.82%
Shaft horsepower = 15
Engine speed = 15016 rpm
Engine exhaust temperature = 749°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 132 pounds per hour

Carbon monoxide	23.55
Carbon dioxide	339.15
Oxides of nitrogen	0.19
Hydrocarbons, $CH_{y/x}$	17.21
Hydrocarbons, CH_4	19.98
Sulfur dioxide	0.05

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 7 JUNE 1979
Engine S/N 271178
Test Cell 12, single point probe 15 feet behind engine exhaust plane.
JP-5 fuel.

A	T58-GE-8F	HIGH IDLE	File T58A55B
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	DEW = 56°F B = 29.81 in. Hg h = 0.015195 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	927.0	sd	929.6	923.9	906.5	152.36
Carbon dioxide	%	1.08	sd	1.07	1.07	1.05	2760.33
Oxides of nitrogen	ppm	5.8	w	6.0	6.0	5.9	1.62
Nitric oxide	ppm			5.8	5.8	5.7	1.57
Nitrogen dioxide	ppm			0.2	0.2	0.2	0.05
Hydrocarbons, $CH_{y/x}$	ppmC	1008.5	w	1034.2	1027.9	1008.5	83.67
Hydrocarbons, CH_4							97.09
Oxygen	%			19.45	19.33	18.96	
Nitrogen	%			79.38	78.90	77.41	
Water	%					2.48	

D Sulfur dioxide, calc. 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 53
Oxides of nitrogen at 3% oxygen, *meas.(ppm wet)*

F
K = 0.9752
F/A = 0.005873
Combustion efficiency = 88.10%
Shaft horsepower = 27
Engine speed = 16987 rpm
Engine exhaust temperature = 743°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 149 pounds per hour

Carbon monoxide	22.70
Carbon dioxide	411.29
Oxides of nitrogen	0.24
Hydrocarbons, $CH_{y/x}$	12.47
Hydrocarbons, CH_4	14.47
Sulfur dioxide	0.06

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 7 JUNE 1979
Engine S/N 271178
Test Cell 12, single point probe 15 feet behind engine exhaust plane.
JP-5 fuel.

A	T58-GE-8F	APPROACH	File T58A56C

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	DEW = 56°F B = 29.81 in. Hg h = 0.015195 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	153.2	sd	150.3	149.4	145.8	17.28
Carbon dioxide	%	1.79	sd	1.78	1.77	1.72	3210.80
Oxides of nitrogen	ppm	22.7	w	23.7	23.6	23.0	4.47
Nitric oxide	ppm			23.0	22.8	22.3	4.33
Nitrogen dioxide	ppm			0.7	0.7	0.7	0.14
Hydrocarbons, $CH_{y/x}$	ppmC	19.1	w	19.7	19.6	19.1	1.12
Hydrocarbons, CH_4							1.30
Oxygen	%			18.57	18.45	18.01	
Nitrogen	%			79.64	79.16	77.23	
Water	%					3.02	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 140
Oxides of nitrogen at 3% oxygen, *meas.(ppm wet)*

F

K = 0.9698
F/A = 0.008346
Combustion efficiency = 99.49%
Shaft horsepower = 918
Engine speed = 24578 rpm
Engine exhaust temperature = 1097°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 581 pounds per hour

Carbon monoxide	10.04
Carbon dioxide	1865.47
Oxides of nitrogen	2.60
Hydrocarbons, $CH_{y/x}$	0.65
Hydrocarbons, CH_4	0.75
Sulfur dioxide	0.23

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 7 JUNE 1979
Engine S/N 271178
Test Cell 12, single point probe 15 feet behind engine exhaust plane.
JP-5 fuel.

A	T58-GE-8F	CRUISE	File T58A31D

B			
	J = -0.07	DEW = 56°F	m = 13.0
	L = -0.0001		n = 23.4
	L' = 0.14	B = 29.80 in. Hg	η = 0.95
	M = -0.00033	h = 0.015201	
	M' = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	129.9	sd	126.9	126.1	123.0	14.13
	Carbon dioxide	%	1.85	sd	1.84	1.83	1.78	3214.97
	Oxides of nitrogen	ppm	24.5	w	25.6	25.4	24.8	4.68
	Nitric oxide	ppm			24.8	24.6	24.0	4.53
	Nitrogen dioxide	ppm			0.8	0.8	0.8	0.15
	Hydrocarbons, $CH_{y/x}$	ppmC	14.1	w	14.5	14.5	14.1	0.80
	Hydrocarbons, CH_4							0.93
	Oxygen	%			18.49	18.38	17.92	
	Nitrogen	%			79.66	79.18	77.21	
	Water	%					3.07	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 147
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9693
F/A = 0.008613
Combustion efficiency = 99.59%
Shaft horsepower = 1027
Engine speed = 24983 rpm
Engine exhaust temperature = 1126°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 627 pounds per hour

Carbon monoxide	8.86
Carbon dioxide	2015.79
Oxides of nitrogen	2.94
Hydrocarbons, $CH_{y/x}$	0.50
Hydrocarbons, CH_4	0.58
Sulfur dioxide	0.25

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 6 JUNE 1979
Engine S/N 271178
Test Cell 12, single point probe 15 feet behind engine exhaust plane.
JP-5 fuel.

A

T58-GE-8F **MAXIMUM CONTINUOUS** **File T58A58N**

B

J = -0.07	DEW = 56°F	m = 13.0
L = -0.0001		n = 23.4
L' = 0.14	B = 29.81 in. Hg	η = 0.95
M = -0.00033	h = 0.015195	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	125.9	sd	122.7	122.0	118.9	12.96
Carbon dioxide	%	1.95	sd	1.94	1.93	1.88	3214.12
Oxides of nitrogen	ppm	27.0	w	28.2	28.1	27.4	4.90
Nitric oxide	ppm			27.4	27.2	26.5	4.75
Nitrogen dioxide	ppm			0.9	0.9	0.9	0.15
Hydrocarbons, $CH_{y/x}$	ppmC	13.6	w	14.0	14.0	13.6	0.73
Hydrocarbons, CH_4							0.85
Oxygen	%			18.35	18.24	17.77	
Nitrogen	%			79.70	79.21	77.18	
Water	%					3.15	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 155
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9685
F/A = 0.009078
Combustion efficiency = 99.63%
Shaft horsepower = 1159
Engine speed = 25592 rpm
Engine exhaust temperature = 1180°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 685 pounds per hour

Carbon monoxide	8.88
Carbon dioxide	2201.67
Oxides of nitrogen	3.36
Hydrocarbons, $CH_{y/x}$	0.50
Hydrocarbons, CH_4	0.58
Sulfur dioxide	0.27

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 7 JUNE 1979
Engine S/N 271178
Test Cell 12, single point probe 15 feet behind engine exhaust plane.
JP-5 fuel.

A	T58-GE-8F	TAKEOFF	File T58A76M

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	DEW = 56°F B = 29.81 in. Hg h = 0.015195 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	96.4	sd	92.9	92.3	89.8	9.03
Carbon dioxide	%	2.12	sd	2.11	2.09	2.04	3217.15
Oxides of nitrogen	ppm	32.7	w	34.3	34.1	33.1	5.47
Nitric oxide	ppm			33.2	33.0	32.1	5.30
Nitrogen dioxide	ppm			1.1	1.1	1.0	0.17
Hydrocarbons, $CH_{y/x}$	ppmC	8.0	w	8.3	8.2	8.0	0.40
Hydrocarbons, CH_4							0.46
Oxygen	%			18.13	18.02	17.53	
Nitrogen	%			79.76	79.27	77.13	
Water	%					3.30	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 174
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9670
F/A = 0.009854
Combustion efficiency = 99.75%
Shaft horsepower = 1360
Engine speed = 26689 rpm
Engine exhaust temperature = 1275°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 786 pounds per hour

Carbon monoxide	7.10
Carbon dioxide	2528.68
Oxides of nitrogen	4.30
Hydrocarbons, $CH_{y/x}$	0.31
Hydrocarbons, CH_4	0.36
Sulfur dioxide	0.31

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 7 JUNE 1979
Engine S/N 271178
Test Cell 12, single point probe 15 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-6B	IDLE	File T64001I
B	J = −0.07 L = −0.0008 L′ = 0.14 M = −0.00185 M′ = 0.28	T = 57°F RH = 64% B = 30.09 in. Hg h = 0.009929 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	417.2	sd	397.5	395.1	388.7	57.27
	Carbon dioxide	%	1.39	sd	1.38	1.37	1.35	3124.03
	Oxides of nitrogen	ppm	11.5	sd	11.6	11.6	11.4	2.75
	Nitric oxide	ppm			11.3	11.2	11.0	2.67
	Nitrogen dioxide	ppm			0.4	0.4	0.4	0.09
	Hydrocarbons, $CH_{y/x}$	ppmC	182.0	w	186.1	185.0	182.0	13.24
	Hydrocarbons, CH_4							15.36
	Oxygen	%			19.08	18.97	18.66	
	Nitrogen	%			79.50	79.02	77.75	
	Water	%					2.20	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	89
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9780
F/A = 0.006671
Combustion efficiency = 97.35%
Shaft horsepower = 119
Engine speed = 13459 rpm
Engine exhaust temperature = 840°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 321 pounds per hour

Carbon monoxide	18.38
Carbon dioxide	1002.81
Oxides of nitrogen	0.88
Hydrocarbons, $CH_{y/x}$	4.25
Hydrocarbons, CH_4	4.93
Sulfur dioxide	0.13

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 JANUARY 1974
Engine S/N 262265
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-6B	75% hp	File T64001B

B			
	J = -0.07	T = 57°F	m = 13.0
	L = -0.0008	RH = 64%	n = 23.4
	L' = 0.14	B = 30.09 in. Hg	η = 0.95
	M = -0.00185	h = 0.009929	
	M' = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	61.7	sd	36.7	36.5	35.8	4.27
	Carbon dioxide	%	1.78	sd	1.77	1.76	1.72	3234.24
	Oxides of nitrogen	ppm	40.3	sd	40.8	40.5	39.8	7.80
	Nitric oxide	ppm			39.5	39.3	38.5	7.55
	Nitrogen dioxide	ppm			1.3	1.3	1.3	0.25
	Hydrocarbons, $CH_{y/x}$	ppmC	7.0	w	7.2	7.1	7.0	0.41
	Hydrocarbons, CH_4							0.48
	Oxygen	%			18.59	18.48	18.12	
	Nitrogen	%			79.63	79.15	77.64	
	Water	%					2.50	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 253
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9750
F/A = 0.008240
Combustion efficiency = 99.86%
Shaft horsepower = 2052
Engine speed = 16650 rpm
Engine exhaust temperature = 1022°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1063 pounds per hour

Carbon monoxide	4.54
Carbon dioxide	3437.99
Oxides of nitrogen	8.29
Hydrocarbons, $CH_{y/x}$	0.44
Hydrocarbons, CH_4	0.51
Sulfur dioxide	0.43

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 JANUARY 1974
Engine S/N 262265
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-6B	NORMAL RATED	File T64001N
B	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00185 M' = 0.28	T = 57°F RH = 64% B = 30.09 in. Hg h = 0.009929 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	49.7	sd	25.1	25.0	24.5	2.66
	Carbon dioxide	%	1.96	sd	1.95	1.93	1.90	3231.12
	Oxides of nitrogen	ppm	51.1	sd	51.7	51.4	50.3	8.97
	Nitric oxide	ppm			50.1	49.8	48.8	8.69
	Nitrogen dioxide	ppm			1.6	1.6	1.6	0.28
	Hydrocarbons, $CH_{y/x}$	ppmC	9.0	w	9.2	9.2	9.0	0.48
	Hydrocarbons, CH_4							0.56
	Oxygen	%			18.35	18.24	17.86	
	Nitrogen	%			79.70	79.22	77.58	
	Water	%					2.65	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 293

Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9735
F/A = 0.009076
Combustion efficiency = 99.89%
Shaft horsepower = 2679
Engine speed = 17096 rpm
Engine exhaust temperature = 1098°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1262 pounds per hour

Carbon monoxide	3.35
Carbon dioxide	4077.68
Oxides of nitrogen	11.32
Hydrocarbons, $CH_{y/x}$	0.61
Hydrocarbons, CH_4	0.71
Sulfur dioxide	0.50

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 JANUARY 1974
Engine S/N 262265
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	**T64-GE-6B**	**MILITARY**	**File T64001M**

B	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00185 M' = 0.28	T = 57°F RH = 64% B = 30.09 in. Hg h = 0.009929 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	43.7	sd	18.5	18.4	18.0	1.87
	Carbon dioxide	%	2.05	sd	2.04	2.02	1.98	3229.91
	Oxides of nitrogen	ppm	58.4	sd	59.1	58.8	57.5	9.80
	Nitric oxide	ppm			57.2	56.9	55.7	9.49
	Nitrogen dioxide	ppm			1.9	1.9	1.8	0.31
	Hydrocarbons, $CH_{y/x}$	ppmC	10.0	w	10.3	10.2	10.0	0.51
	Hydrocarbons, CH_4							0.59
	Oxygen	%			18.23	18.12	17.73	
	Nitrogen	%			79.73	79.25	77.55	
	Water	%					2 73	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 321
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9727
F/A = 0.009493
Combustion efficiency = 99.91%
Shaft horsepower = 3004
Engine speed = 17544 rpm
Engine exhaust temperature = 1147°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1370 pounds per hour

Carbon monoxide	2.56
Carbon dioxide	4424.98
Oxides of nitrogen	13.43
Hydrocarbons, $CH_{y/x}$	0.70
Hydrocarbons, CH_4	0.81
Sulfur dioxide	0.55

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 JANUARY 1974
Engine S/N 262265
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-6B	MAXIMUM CONTINUOUS	File T64001X

B	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00185 M' = 0.28	T = 57°F RH = 64% B = 30.09 in. Hg h = 0.009929 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	40.8	sd	15.2	15.1	14.8	1.50
	Carbon dioxide	%	2.10	sd	2.09	2.07	2.03	3229.15
	Oxides of nitrogen	ppm	61.7	sd	62.5	62.1	60.7	10.11
	Nitric oxide	ppm			60.5	60.1	58.8	9.79
	Nitrogen dioxide	ppm			2.0	2.0	1.9	0.32
	Hydrocarbons, $CH_{y/x}$	ppmC	11.0	w	11.3	11.2	11.0	0.55
	Hydrocarbons, CH_4							0.64
	Oxygen	%			18.16	18.05	17.66	
	Nitrogen	%			79.75	79.27	77.54	
	Water	%					2.77	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 331
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9723
F/A = 0.009726
Combustion efficiency = 99.91%
Shaft horsepower = 3167
Engine speed = 17761 rpm
Engine exhaust temperature = 1147°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1428 pounds per hour

Carbon monoxide	2.14
Carbon dioxide	4611.22
Oxides of nitrogen	14.43
Hydrocarbons, $CH_{y/x}$	0.79
Hydrocarbons, CH_4	0.91
Sulfur dioxide	0.57

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 10 JANUARY 1974
Engine S/N 262265
Test Cell 9, single point probe 40 feet behind engine exhaust plane
JP-5 fuel.

AESO 09-30-1981

A	T64-GE-413	IDLE	File T64031I

B			
	J = -0.07 L = -0.0008 L' = 0.14 M = -0.00281 M' = 0.28	T = 57°F RH = 59% B = 30.16 in. Hg h = 0.009124 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	380.5	sd	354.9	352.7	347.4	51.83
	Carbon dioxide	%	1.37	sd	1.36	1.35	1.33	3120.68
	Oxides of nitrogen	ppm	10.8	sd	10.9	10.9	10.7	2.62
	Nitric oxide	ppm			10.6	10.5	10.4	2.54
	Nitrogen dioxide	ppm			0.3	0.3	0.3	0.08
	Hydrocarbons, $CH_{y/x}$	ppmC	234.7	w	239.7	238.3	234.7	17.28
	Hydrocarbons, CH_4							20.05
	Oxygen	%			19.11	19.00	18.71	
	Nitrogen	%			79.49	79.01	77.82	
	Water	%					2.10	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 86
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9790
F/A = 0.006582
Combustion efficiency = 97.07%
Shaft horsepower = 64
Engine speed = 11985 rpm
Engine exhaust temperature = 824°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 260 pounds per hour

Carbon monoxide	13.48
Carbon dioxide	811.38
Oxides of nitrogen	0.68
Hydrocarbons, $CH_{y/x}$	4.49
Hydrocarbons, CH_4	5.21
Sulfur dioxide	0.10

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 28 JANUARY 1974
Engine S/N 264274
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-413	75% HP	File T64031B
B	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00281 M' = 0.28	T = 57°F RH = 59% B = 30.16 in. Hg h = 0.009124 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	47.8	sd	17.8	17.7	17.4	1.94
	Carbon dioxide	%	1.90	sd	1.89	1.88	1.84	3234.40
	Oxides of nitrogen	ppm	47.1	sd	47.7	47.4	46.5	8.54
	Nitric oxide	ppm			46.2	45.9	45.0	8.27
	Nitrogen dioxide	ppm			1.5	1.5	1.5	0.27
	Hydrocarbons, $CH_{y/x}$	ppmC	6.3	w	6.5	6.4	6.3	0.35
	Hydrocarbons, CH_4							0.40
	Oxygen	%			18.43	18.32	17.96	
	Nitrogen	%			79.68	79.20	77.66	
	Water	%					2.53	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 279
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9747
F/A = 0.008791
Combustion efficiency = 99.92%
Shaft horsepower = 2699
Engine speed = 16875 rpm
Engine exhaust temperature = 1119°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1287 pounds per hour

Carbon monoxide	2.50
Carbon dioxide	4162.67
Oxides of nitrogen	10.99
Hydrocarbons, $CH_{y/x}$	0.45
Hydrocarbons, CH_4	0.52
Sulfur dioxide	0.51

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 28 JANUARY 1974
Engine S/N 264274
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-413	NORMAL RATED	File T64031N

B			
	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00281 M' = 0.28	T = 57°F RH = 59% B = 30.16 in. Hg h = 0.009124 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	43.4	sd	12.1	12.0	11.8	1.20
Carbon dioxide	%	2.09	sd	2.08	2.06	2.02	3230.58
Oxides of nitrogen	ppm	58.6	sd	59.3	59.0	57.7	9.65
Nitric oxide	ppm			57.4	57.1	55.9	9.34
Nitrogen dioxide	ppm			1.9	1.9	1.8	0.30
Hydrocarbons, $CH_{y/x}$	ppmC	6.6	w	6.8	6.7	6.6	0.33
Hydrocarbons, CH_4							0.38
Oxygen	%			18.17	18.06	17.68	
Nitrogen	%			79.74	79.26	77.60	
Water	%					2.69	

D

Sulfur dioxide, calc. 0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 317
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9731
F/A = 0.009675
Combustion efficiency = 99.94%
Shaft horsepower = 3345
Engine speed = 17274 rpm
Engine exhaust temperature = 1203°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1511 pounds per hour

Carbon monoxide	1.81
Carbon dioxide	4881.40
Oxides of nitrogen	14.58
Hydrocarbons, $CH_{y/x}$	0.50
Hydrocarbons, CH_4	0.58
Sulfur dioxide	0.60

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 28 JANUARY 1974
Engine S/N 264274
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-413	INTERMEDIATE	File T64031M

B

J = -0.07	T = 57°F	m = 13.0
L = -0.0007	RH = 59%	n = 23.4
L' = 0.14	B = 30.16 in. Hg	η = 0.95
M = -0.00281	h = 0.009124	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	39.7	sd	7.3	7.3	7.1	0.67
Carbon dioxide	%	2.24	sd	2.23	2.21	2.16	3227.98
Oxides of nitrogen	ppm	71.1	sd	72.0	71.6	70.0	10.92
Nitric oxide	ppm			69.7	69.3	67.8	10.57
Nitrogen dioxide	ppm			2.3	2.3	2.2	0.34
Hydrocarbons, $CH_{y/x}$	ppmC	7.3	w	7.5	7.5	7.3	0.34
Hydrocarbons, CH_4							0.40
Oxygen	%			17.97	17.86	17.46	
Nitrogen	%			79.80	79.31	77.55	
Water	%					2.81	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 360
Oxides of nitrogen at 3% oxygen, *meas.(ppm wet)*

F

K = 0.9719
F/A = 0.010373
Combustion efficiency = 99.95%
Shaft horsepower = 3779
Engine speed = 17472 rpm
Engine exhaust temperature = 1203°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1661 pounds per hour

Carbon monoxide	1.12
Carbon dioxide	5361.68
Oxides of nitrogen	18.13
Hydrocarbons, $CH_{y/x}$	0.57
Hydrocarbons, CH_4	0.66
Sulfur dioxide	0.66

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 28 JANUARY 1974
Engine S/N 264274
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	**T64–GE–413**	**MAXIMUM**	**File T64031X**
B	J = −0.07 L = −0.0007 L′ = 0.14 M = −0.00281 M′ = 0.28	T = 57°F RH = 59% B = 30.16 in. Hg h = 0.009124 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	38.4	sd	5.5	5.5	5.4	0.49
	Carbon dioxide	%	2.31	sd	2.30	2.28	2.23	3227.08
	Oxides of nitrogen	ppm	76.7	sd	77.7	77.2	75.4	11.42
	Nitric oxide	ppm			75.2	74.8	73.1	11.06
	Nitrogen dioxide	ppm			2.4	2.4	2.4	0.36
	Hydrocarbons, $CH_{y/x}$	ppmC	5.9	w	6.1	6.0	5.9	0.27
	Hydrocarbons, CH_4							0.31
	Oxygen	%			17.88	17.77	17.36	
	Nitrogen	%			79.82	79.34	77.53	
	Water	%					2.87	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 378
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9713
F/A = 0.010697
Combustion efficiency = 99.96%
Shaft horsepower = 3937
Engine speed = 17589 rpm
Engine exhausc temperature = 1203°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1721 pounds per hour

Carbon monoxide	0.85
Carbon dioxide	5553.80
Oxides of nitrogen	19.65
Hydrocarbons, $CH_{y/x}$	0.46
Hydrocarbons, CH_4	0.54
Sulfur dioxide	0.69

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 28 JANUARY 1974
Engine S/N 264274
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	**T64-GE-415**	**IDLE**	**File T640511**
B	J = -0.07 L = -0.0008 L' = 0.14 M = -0.00578 M' = 0.28	T = 64°F RH = 56% B = 29.87 in. Hg h = 0.011216 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	573.2	sd	530.5	527.3	518.1	74.33
	Carbon dioxide	%	1.40	sd	1.39	1.38	1.36	3059.84
	Oxides of nitrogen	ppm	9.1	sd	9.2	9.1	9.0	2.12
	Nitric oxide	ppm			8.9	8.9	8.7	2.05
	Nitrogen dioxide	ppm			0.3	0.3	0.3	0.07
	Hydrocarbons, $CH_{y/x}$	ppmC	343.8	w	352.0	349.9	343.8	24.35
	Hydrocarbons, CH_4							28.25
	Oxygen	%			19.06	18.94	18.61	
	Nitrogen	%			79.50	79.02	77.64	
	Water	%					2.34	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 69

Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9766

F/A = 0.006860

Combustion efficiency = 95.84%

Shaft horsepower = 41

Engine speed = 11755 rpm

Engine exhaust temperature = 877°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 269 pounds per hour

Carbon monoxide	20.00
Carbon dioxide	823.10
Oxides of nitrogen	0.57
Hydrocarbons, $CH_{y/x}$	6.55
Hydrocarbons, CH_4	7.60
Sulfur dioxide	0.11

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE

Measurement at NAVAIREWORKFAC NORTH ISLAND

Date of measurement 23 OCTOBER 1975

Engine S/N 264453

Test Cell 9, single point probe 40 feet behind engine exhaust plane.

JP-5 fuel.

A	T64-GE-415	75%	File T64051B

B			
	J = -0.07	T = 64°F	m = 13.0
	L = -0.0006	RH = 56%	n = 23.4
	L' = 0.14	B = 29.87 in. Hg	η = 0.95
	M = -0.00578	h = 0.011216	
	M' = 0.28	h_{sd} = 0.00607	

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	75.2	sd	25.6	25.4	24.8	2.10
	Carbon dioxide	%	2.51	sd	2.49	2.48	2.41	3221.31
	Oxides of nitrogen	ppm	59.2	sd	60.0	59.6	58.0	8.09
	Nitric oxide	ppm			58.1	57.7	56.2	7.84
	Nitrogen dioxide	ppm			1.9	1.9	1.8	0.26
	Hydrocarbons, $CH_{y/x}$	ppmC	3.2	w	3.3	3.3	3.2	0.13
	Hydrocarbons, CH_4							0.16
	Oxygen	%			17.60	17.50	17.03	
	Nitrogen	%			79.89	79.41	77.30	
	Water	%					3.24	

D	Sulfur dioxide, calc.	0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	266
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9676
F/A = 0.011636
Combustion efficiency = 99.94%
Shaft horsepower = 3066
Engine speed = 17170 rpm
Engine exhaust temperature = 1219°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1493 pounds per hour

Carbon monoxide	3.14
Carbon dioxide	4809.41
Oxides of nitrogen	12.09
Hydrocarbons, $CH_{y/x}$	0.20
Hydrocarbons, CH_4	0.23
Sulfur dioxide	0.60

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 23 OCTOBER 1975
Engine S/N 264453
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-415	NORMAL RATED	File T64051N

B			
	J = −0.07 L = −0.0006 L′ = 0.14 M = −0.00578 M′ = 0.28	T = 64°F RH = 56% B = 29.87 in. Hg h = 0.011216 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	70.7	sd	19.8	19.7	19.1	1.50
	Carbon dioxide	%	2.72	sd	2.70	2.69	2.61	3219.21
	Oxides of nitrogen	ppm	73.7	sd	74.7	74.2	72.1	9.29
	Nitric oxide	ppm			72.3	71.9	69.8	9.00
	Nitrogen dioxide	ppm			2.4	2.3	2.3	0.29
	Hydrocarbons, $CH_{y/x}$	ppmC	2.0	w	2.1	2.1	2.0	0.08
	Hydrocarbons, CH_4							0.09
	Oxygen	%			17.32	17.22	16.73	
	Nitrogen	%			79.97	79.48	77.23	
	Water	%					3.42	

D	Sulfur dioxide, calc.	0.40

E		
	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	307
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9658
F/A = 0.012609
Combustion efficiency = 99.96%
Shaft horsepower = 3660
Engine speed = 17536 rpm
Engine exhaust temperature = 1304°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1730 pounds per hour

Carbon monoxide	2.60
Carbon dioxide	5569.23
Oxides of nitrogen	16.08
Hydrocarbons, $CH_{y/x}$	0.13
Hydrocarbons, CH_4	0.16
Sulfur dioxide	0.69

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 23 OCTOBER 1975
Engine S/N 264453
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-415	MILITARY	File T64051M

B			
	$J = -0.07$ $L = -0.0006$ $L' = 0.14$ $M = -0.00578$ $M' = 0.28$	$T = 64°F$ $RH = 56\%$ $B = 29.87$ in. Hg $h = 0.011216$ $h_{sd} = 0.00607$	$m = 13.0$ $n = 23.4$ $\eta = 0.95$

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	69.2	sd	17.7	17.6	17.1	1.29
Carbon dioxide	%	2.82	sd	2.80	2.79	2.70	3217.52
Oxides of nitrogen	ppm	82.2	sd	83.3	82.8	80.4	9.99
Nitric oxide	ppm			80.7	80.2	77.8	9.68
Nitrogen dioxide	ppm			2.6	2.6	2.5	0.32
Hydrocarbons, $CH_{y/x}$	ppmC	7.5	v	7.8	7.7	7.5	0.28
Hydrocarbons, CH_4							0.33
Oxygen	%			17.19	17.08	16.58	
Nitrogen	%			80.00	79.52	77.20	
Water	%					3.50	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 331
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9650
F/A = 0.013075
Combustion efficiency = 99.94%
Shaft horsepower = 4100
Engine speed = 17750 rpm
Engine exhaust temperature = 1373°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1916 pounds per hour

Carbon monoxide	2.48
Carbon dioxide	6164.77
Oxides of nitrogen	19.15
Hydrocarbons, $CH_{y/x}$	0.54
Hydrocarbons, CH_4	0.62
Sulfur dioxide	0.77

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 23 OCTOBER 1975
Engine S/N 264453
Test Cell 9. single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-415	MAXIMUM RATED POWER	File T64051X

B

J = −0.07	T = 64°F	m = 13.0
L = −0.0006	RH = 56%	n = 23.4
L′ = 0.14	B = 29.87 in. Hg	η = 0.95
M = −0.00578	h = 0.011216	
M′ = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	72.2	sd	20.4	20.3	19.7	1.47
Carbon dioxide	%	2.87	sd	2.85	2.84	2.75	3216.87
Oxides of nitrogen	ppm	90.7	sd	91.9	91.4	88.7	10.83
Nitric oxide	ppm			89.0	88.5	85.9	10.49
Nitrogen dioxide	ppm			2.9	2.9	2.8	0.34
Hydrocarbons, $CH_{y/x}$	ppmC	5.3	w	5.5	5.5	5.3	0.19
Hydrocarbons, CH_4							0.23
Oxygen	%			17.12	17.01	16.51	
Nitrogen	%			80.02	79.54	77.18	
Water	%					3.55	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc. (ppm wet)	359
Oxides of nitrogen at 3% oxygen, meas. (ppm wet)	

F

K = 0.9645
F/A = 0.013307
Combustion efficiency = 99.95%
Shaft horsepower = 4372
Engine speed = 17910 rpm
Engine exhaust temperature = 1407°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 2005 pounds per hour

Carbon monoxide	2.94
Carbon dioxide	6449.83
Oxides of nitrogen	21.72
Hydrocarbons, $CH_{y/x}$	0.39
Hydrocarbons, CH_4	0.45
Sulfur dioxide	0.80

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 23 OCTOBER 1975
Engine S/N 264453
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	IDLE	File T64002I

B			
	J = -0.07 L = -0.0008 L' = 0.14 M = -0.00082 M' = 0.28	T = 41°F RH = 64% B = 30.06 in. Hg h = 0.005467 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	371.7	sd	358.2	356.0	352.0	52.84
Carbon dioxide	%	1.36	sd	1.35	1.34	1.33	3129.02
Oxides of nitrogen	ppm	10.6	sd	10.7	10.7	10.5	2.60
Nitric oxide	ppm			10.4	10.3	10.2	2.52
Nitrogen dioxide	ppm			0.3	0.3	0.3	0.08
Hydrocarbons, $CH_{y/x}$	ppmC	194.3	w	197.7	196.5	194.3	14.40
Hydrocarbons, CH_4							16.71
Oxygen	%			19.13	19.01	18.79	
Nitrogen	%			79.49	79.01	78.10	
Water	%					1.74	

D Sulfur dioxide, calc. 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 88
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9826
F/A = 0.006517
Combustion efficiency = 97.33%
Shaft horsepower = 81
Engine speed = 12196 rpm
Engine exhaust temperature = 776°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 262 pounds per hour

Carbon monoxide	13.84
Carbon dioxide	819.80
Oxides of nitrogen	0.68
Hydrocarbons, $CH_{y/x}$	3.77
Hydrocarbons, CH_4	4.38
Sulfur dioxide	0.10

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	75% HORSEPOWER	File T64002B

B

J = −0.07	T = 41°F	m = 13.0
L = −0.0007	RH = 64%	n = 23.4
L′ = 0.14	B = 30.06 in. Hg	η = 0.95
M = −0.00082	h = 0.005467	
M′ = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	40.0	sd	21.4	21.2	20.9	2.21
Carbon dioxide	%	2.00	sd	1.99	1.97	1.94	3231.36
Oxides of nitrogen	ppm	51.1	sd	51.7	51.4	50.6	8.79
Nitric oxide	ppm			50.1	49.8	49.0	8.52
Nitrogen dioxide	ppm			1.6	1.6	1.6	0.28
Hydrocarbons, $CH_{y/x}$	ppmC	5.6	w	5.7	5.7	5.6	0.29
Hydrocarbons, CH_4							0.34
Oxygen	%			18.29	18.18	17.88	
Nitrogen	%			79.71	79.23	77.91	
Water	%					2.26	

D

Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 296
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9774
F/A = 0.009259
Combustion efficiency = 99.92%
Shaft horsepower = 2697
Engine speed = 16761 rpm
Engine exhaust temperature = 1131°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1300 pounds per hour

Carbon monoxide	2.88
Carbon dioxide	4200.77
Oxides of nitrogen	11.43
Hydrocarbons, $CH_{y/x}$	0.38
Hydrocarbons, CH_4	0.44
Sulfur dioxide	0.52

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	NORMAL RATED	File T64002N

B

J = −0.07	T = 41°F	m = 13.0
L = −0.0007	RH = 64%	n = 23.4
L' = 0.14	B = 30.06 in. Hg	η = 0.95
M = −0.00082	h = 0.005467	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	35.7	sd	15.6	15.5	15.3	1.47
Carbon dioxide	%	2.20	sd	2.19	2.17	2.13	3227.62
Oxides of nitrogen	ppm	63.5	sd	64.3	63.9	62.7	9.92
Nitric oxide	ppm			62.3	61.9	60.7	9.61
Nitrogen dioxide	ppm			2.0	2.0	2.0	0.31
Hydrocarbons, $CH_{y/x}$	ppmC	6.9	w	7.1	7.0	6.9	0.33
Hydrocarbons, CH_4							0.38
Oxygen	%			18.02	17.92	17.59	
Nitrogen	%			79.78	79.30	77.84	
Water	%					2.43	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 335
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9757
F/A = 0.010190
Combustion efficiency = 99.93%
Shaft horsepower = 3729
Engine speed = 17365 rpm
Engine exhaust temperature = 1275°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1676 pounds per hour

Carbon monoxide	2.46
Carbon dioxide	5409.49
Oxides of nitrogen	16.63
Hydrocarbons, $CH_{y/x}$	0.55
Hydrocarbons, CH_4	0.64
Sulfur dioxide	0.67

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	INTERMEDIATE	File T64002M

B			
	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00082 M' = 0.28	T = 41°F RH = 64% B = 30.06 in. Hg h = 0.005467 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	35.7	sd	14.5	14.4	14.1	1.26
	Carbon dioxide	%	2.37	sd	2.35	2.34	2.29	3224.58
	Oxides of nitrogen	ppm	75.0	sd	75.9	75.5	74.0	10.87
	Nitric oxide	ppm			73.6	73.1	71.7	10.53
	Nitrogen dioxide	ppm			2.4	2.4	2.3	0.34
	Hydrocarbons, $CH_{y/x}$	ppmC	6.9	w	7.1	7.0	6.9	0.30
	Hydrocarbons, CH_4							0.35
	Oxygen	%			17.79	17.69	17.34	
	Nitrogen	%			79.84	79.36	77.79	
	Water	%					2.58	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 368
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9742
F/A = 0.010981
Combustion efficiency = 99.94%
Shaft horsepower = 3729
Engine speed = 17365 rpm
Engine exhaust temperature = 1275°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1676 pounds per hour

Carbon monoxide	2.11
Carbon dioxide	5404.40
Oxides of nitrogen	18.22
Hydrocarbons, $CH_{y/x}$	0.51
Hydrocarbons, CH_4	0.59
Sulfur dioxide	0.67

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 40 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	MAXIMUM	File T64002X

B	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00082 M' = 0.28	T = 41°F RH = 64% B = 30.06 in. Hg h = 0.005467 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	37.1	sd	15.5	15.4	15.1	1.32
	Carbon dioxide	%	2.42	sd	2.40	2.39	2.34	3223.70
	Oxides of nitrogen	ppm	80.2	sd	81.2	80.7	79.1	11.38
	Nitric oxide	ppm			78.7	78.2	76.6	11.02
	Nitrogen dioxide	ppm			2.6	2.5	2.5	0.36
	Hydrocarbons, $CH_{y/x}$	ppmC	6.1	w	6.3	6.2	6.1	0.26
	Hydrocarbons, CH_4							0.31
	Oxygen	%			17.73	17.62	17.26	
	Nitrogen	%			79.86	79.38	77.77	
	Water	%					2.62	

D	Sulfur dioxide, calc.	0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	385
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F	K = 0.9738 F/A = 0.011214 Combustion efficiency = 99.94% Shaft horsepower = 3870 Engine speed = 17471 rpm Engine exhaust temperature = 1299°F

G	EMISSION RATE (pounds of constituent per hour) for a fuel flow rate of 1731 pounds per hour	
	Carbon monoxide	2.29
	Carbon dioxide	5580.22
	Cxides of nitrogen	19.70
	Hydrocarbons, $CH_{y/x}$	0.46
	Hydrocarbons, CH_4	0.53
	Sulfur dioxide	0.69

H	Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE Measurement at NAVAIREWORKFAC NORTH ISLAND Date of measurement 29 JANUARY 1974 Engine S/N 261033 Test Cell 9, single point probe 40 feet behind engine exhaust plane. JP-5 fuel.

A	T64-GE-7	IDLE	File T64003I

B			
	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00082 M' = 0.28	T = 41°F RH = 64% B = 30.06 in. Hg h = 0.005467 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
Carbon monoxide	ppm	576.7	sd	560.7	557.3	547.3	53.38
Carbon dioxide	%	2.09	sd	2.08	2.06	2.03	3105.69
Oxides of nitrogen	ppm	19.1	sd	19.3	19.2	18.9	3.02
Nitric oxide	ppm			18.7	18.6	18.3	2.93
Nitrogen dioxide	ppm			0.6	0.6	0.6	0.10
Hydrocarbons, $CH_{y/x}$	ppmC	274.1	w	280.8	279.1	274.1	13.19
Hydrocarbons, CH_4							15.31
Oxygen	%			18.12	18.01	17.69	
Nitrogen	%			79.74	79.26	77.84	
Water	%					2.38	

D Sulfur dioxide, calc. — 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 104
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9762
F/A = 0.010065
Combustion efficiency = 97.44%
Shaft horsepower = 81
Engine speed = 12196 rpm
Engine exhaust temperature = 776°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 262 pounds per hour

Carbon monoxide	13.99
Carbon dioxide	813.69
Oxides of nitrogen	0.79
Hydrocarbons, $CH_{y/x}$	3.46
Hydrocarbons, CH_4	4.01
Sulfur dioxide	0.10

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 0.8 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	75% HORSEPOWER	File T64003B

B

J = -0.07	T = 41°F	m = 13.0
L = -0.0006	RH = 64%	n = 23.4
L′ = 0.14	B = 30.06 in. Hg	η = 0.95
M = -0.00082	h = 0.005467	
M′ = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	53.8	sd	30.9	30.7	29.9	2.08
Carbon dioxide	%	3.06	sd	3.04	3.02	2.95	3213.53
Oxides of nitrogen	ppm	84.7	sd	85.9	85.3	83.1	9.48
Nitric oxide	ppm			83.1	82.6	80.5	9.18
Nitrogen dioxide	ppm			2.7	2.7	2.6	0.30
Hydrocarbons, $CH_{y/x}$	ppmC	6.6	w	6.8	6.8	6.6	0.23
Hydrocarbons, CH_4							0.26
Oxygen	%			16.86	16.76	16.33	
Nitrogen	%			80.09	79.60	77.55	
Water	%					3.16	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 323
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9684
F/A = 0.014193
Combustion efficiency = 99.93%
Shaft horsepower = 2697
Engine speed = 16761 rpm
Engine exhaust temperature = 1131°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1300 pounds per hour

Carbon monoxide	2.70
Carbon dioxide	4177.59
Oxides of nitrogen	12.32
Hydrocarbons, $CH_{y/x}$	0.29
Hydrocarbons, CH_4	0.34
Sulfur dioxide	0.52

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 0.8 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	NORMAL RATED	File T64003N

B			
	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00082 M' = 0.28	T = 41°F RH = 64% B = 30.06 in. Hg h = 0.005467 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	44.4	sd	19.6	19.5	18.9	1.19
Carbon dioxide	%	3.37	sd	3.35	3.33	3.24	3211.69
Oxides of nitrogen	ppm	105.5	sd	107.0	106.3	103.3	10.72
Nitric oxide	ppm			103.6	103.0	100.1	10.38
Nitrogen dioxide	ppm			3.4	3.4	3.3	0.34
Hydrocarbons, $CH_{y/x}$	ppmC	8.2	w	8.5	8.4	8.2	0.26
Hydrocarbons, CH_4							0.30
Oxygen	%			16.44	16.34	15.88	
Nitrogen	%			80.19	79.71	77.45	
Water	%					3.42	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 366
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9658
F/A = 0.015623
Combustion efficiency = 99.95%
Shaft horsepower = 3279
Engine speed = 17111 rpm
Engine exhaust temperature = 1208°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1504 pounds per hour

Carbon monoxide	1.80
Carbon dioxide	4830.38
Oxides of nitrogen	16.12
Hydrocarbons, $CH_{y/x}$	0.38
Hydrocarbons, CH_4	0.45
Sulfur dioxide	0.60

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 0.8 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	INTERMEDIATE	File T64003M

B			
	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00082 M' = 0.28	T = 41°F RH = 64% B = 30.06 in. Hg h = 0.005467 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	45.9	sd	19.5	19.4	18.8	1.10
Carbon dioxide	%	3.64	sd	3.62	3.60	3.49	3209.59
Oxides of nitrogen	ppm	126.9	sd	128.7	128.0	124.0	11.93
Nitric oxide	ppm			124.7	123.9	120.1	11.55
Nitrogen dioxide	ppm			4.1	4.0	3.9	0.38
Hydrocarbons, $CH_{y/x}$	ppmC	8.2	w	8.5	8.5	8.2	0.24
Hydrocarbons, CH_4							0.27
Oxygen	%			16.07	15.98	15.49	
Nitrogen	%			80.29	79.81	77.36	
Water	%					3.65	

D Sulfur dioxide, calc. 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 408
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9635
F/A = 0.016870
Combustion efficiency = 99.95%
Shaft horsepower = 3729
Engine speed = 17365 rpm
Engine exhaust temperature = 1275°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1676 pounds per hour

Carbon monoxide	1.84
Carbon dioxide	5379.28
Oxides of nitrogen	19.99
Hydrocarbons, $CH_{y/x}$	0.40
Hydrocarbons, CH_4	0.46
Sulfur dioxide	0.67

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 0.8 feet behind engine exhaust plane.
JP-5 fuel.

A	T64-GE-7	MAXIMUM	File T64003X

B	J = −0.07 L = −0.0006 L′ = 0.14 M = −0.00082 M′ = 0.28	T = 41°F RH = 64% B = 30.06 in. Hg h = 0.005467 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	48.8	sd	21.7	21.6	20.9	1.19
	Carbon dioxide	%	3.75	sd	3.73	3.71	3.59	3208.65
	Oxides of nitrogen	ppm	137.2	sd	139.2	138.4	134.0	12.51
	Nitric oxide	ppm			134.8	134.0	129.8	12.12
	Nitrogen dioxide	ppm			4.4	4.4	4.2	0.39
	Hydrocarbons, $CH_{y/x}$	ppmC	8.0	w	8.3	8.3	8.0	0.22
	Hydrocarbons, CH_4							0.26
	Oxygen	%			15.92	15.83	15.33	
	Nitrogen	%			80.33	79.84	77.32	
	Water	%					3.74	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 428
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9626
F/A = 0.017378
Combustion efficiency = 99.95%
Shaft horsepower = 3870
Engine speed = 17471 rpm
Engine exhaust temperature = 1299°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 1731 pounds per hour

Carbon monoxide	2.06
Carbon dioxide	5554.18
Oxides of nitrogen	21.66
Hydrocarbons, $CH_{y/x}$	0.39
Hydrocarbons, CH_4	0.45
Sulfur dioxide	0.69

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC NORTH ISLAND
Date of measurement 29 JANUARY 1974
Engine S/N 261033
Test Cell 9, single point probe 0.8 feet behind engine exhaust plane.
JP-5 fuel.

A	T76-G-12A	GROUND START	File T76001I
B	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00593 M' = 0.28	T = 63°F RH = 79% B = 29.84 in. Hg h = 0.015352 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	303.8	sd	256.9	255.3	248.9	28.29
	Carbon dioxide	%	1.84	sd	1.83	1.82	1.77	3162.13
	Oxides of nitrogen	ppm	23.5	sd	23.8	23.6	23.0	4.30
	Nitric oxide	ppm			23.0	22.9	22.3	4.17
	Nitrogen dioxide	ppm			0.7	0.7	0.7	0.14
	Hydrocarbons, $CH_{y/x}$	ppmC	182.0	w	187.8	186.7	182.0	10.21
	Hydrocarbons, CH_4							11.85
	Oxygen	%			18.49	18.38	17.92	
	Nitrogen	%			79.66	79.17	77.20	
	Water	%					3.09	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 136
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9691
F/A = 0.008710
Combustion efficiency = 98.32%
Engine speed = 40500 rpm
Engine exhaust temperature = 620°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 180 pounds per hour

Carbon monoxide	5.09
Carbon dioxide	569.18
Oxides of nitrogen	0.77
Hydrocarbons, $CH_{y/x}$	1.84
Hydrocarbons, CH_4	2.13
Sulfur dioxide	0.07

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 26 AUGUST 1975
Engine S/N 000427
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	T76-G-12A	HIGH IDLE	File T76001B
B	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00593 M' = 0.28	T = 63°F RH = 79% B = 29.84 in. Hg h = 0.015352 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	323.4	sd	273.6	272.0	264.2	24.59
	Carbon dioxide	%	2.26	sd	2.25	2.23	2.17	3170.73
	Oxides of nitrogen	ppm	30.1	sd	30.5	30.3	29.4	4.50
	Nitric oxide	ppm			29.5	29.3	28.5	4.36
	Nitrogen dioxide	ppm			1.0	1.0	0.9	0.14
	Hydrocarbons, $CH_{y/x}$	ppmC	133.5	w	138.3	137.4	133.5	6.13
	Hydrocarbons, CH_4							7.12
	Oxygen	%			17.92	17.81	17.30	
	Nitrogen	%			79.80	79.32	77.06	
	Water	%					3.44	
D	Sulfur dioxide, calc.							0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 145
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9656
F/A = 0.010654
Combustion efficiency = 98.82%
Engine speed = 40100 rpm
Engine exhaust temperature = 715°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 212 pounds per hour

Carbon monoxide	5.21
Carbon dioxide	672.19
Oxides of nitrogen	0.95
Hydrocarbons, $CH_{y/x}$	1.30
Hydrocarbons, CH_4	1.51
Sulfur dioxide	0.08

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 26 AUGUST 1975
Engine S/N 000427
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	T76-G-12A	MILITARY	File T76001M

B			
	J = −0.07 L = −0.0006 L' = 0.14 M = −0.00593 M' = 0.28	T = 63°F RH = 79% B = 29.84 in. Hg h = 0.015352 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	95.6	sd	34.9	34.7	33.2	1.69
	Carbon dioxide	%	4.23	sd	4.21	4.19	4.00	3205.27
	Oxides of nitrogen	ppm	88.9	sd	90.3	89.7	85.7	7.18
	Nitric oxide	ppm			87.4	86.9	83.0	6.96
	Nitrogen dioxide	ppm			2.8	2.8	2.7	0.23
	Hydrocarbons, $CH_{y/x}$	ppmC	1.9	w	2.0	2.0	1.9	0.05
	Hydrocarbons, CH_4							0.06
	Oxygen	%			15.28	15.18	14.50	
	Nitrogen	%			80.50	80.02	76.43	
	Water	%					5.06	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 239
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9494
F/A = 0.019591
Combustion efficiency = 99.96%
Engine speed = 41700 rpm
Engine exhaust temperature = 1054°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 382 pounds per hour

Carbon monoxide	0.65
Carbon dioxide	1224.41
Oxides of nitrogen	2.74
Hydrocarbons, $CH_{y/x}$	0.02
Hydrocarbons, CH_4	0.02
Sulfur dioxide	0.15

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 26 AUGUST 1975
Engine S/N 000427
Test stand, single point probe at engine exhaust plane.

A	T400-CP-400	GROUND IDLE	File T40001I
B	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00626 M' = 0.28	T = 75°F RH = 47% B = 29.83 in. Hg h = 0.013930 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	511.0	sd	457.7	454.9	439.3	29.78
	Carbon dioxide	%	3.09	sd	3.07	3.05	2.95	3141.05
	Oxides of nitrogen	ppm	28.2	sd	28.6	28.4	27.4	3.05
	Nitric oxide	ppm			27.7	27.5	26.6	2.96
	Nitrogen dioxide	ppm			0.9	0.9	0.9	0.10
	Hydrocarbons, $CH_{y/x}$	ppmC	268.3	w	279.5	277.9	268.3	8.98
	Hydrocarbons, CH_4							10.42
	Oxygen	%			16.78	16.68	16.11	
	Nitrogen	%			80.10	79.61	76.88	
	Water	%					4.02	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 102

Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9598

F/A = 0.014662

Combustion efficiency = 98.41%

Torque = 3 foot pounds

Engine speed = 3366 rpm

Engine exhaust temperature = 1038°F

G

EMISSION RATE (pounds of constituent per hour) for a fuel flow rate of 138 pounds per hour

Carbon monoxide	4.11
Carbon dioxide	433.47
Oxides of nitrogen	0.42
Hydrocarbons, $CH_{y/x}$	1.24
Hydrocarbons, CH_4	1.44
Sulfur dioxide	0.06

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE

Measurement at MCAS CAMP PENDLETON

Date of measurement 25 AUGUST 1975

Engine S/N 64100

Test stand, single point probe at engine exhaust plane.

JP-5 fuel.

A	T400-CP-400	FLIGHT IDLE	File T40001B
B	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00626 M' = 0.28	T = 75°F RH = 47% B = 29.83 in. Hg h = 0.013930 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	520.0	sd	466.9	464.1	448.2	30.71
	Carbon dioxide	%	3.06	sd	3.04	3.02	2.92	3144.78
	Oxides of nitrogen	ppm	28.1	sd	28.5	28.3	27.3	3.08
	Nitric oxide	ppm			27.6	27.4	26.5	2.98
	Nitrogen dioxide	ppm			0.9	0.9	0.9	0.10
	Hydrocarbons, $CH_{y/x}$	ppmC	220.5	w	229.7	228.3	220.5	7.46
	Hydrocarbons, CH_4							8.65
	Oxygen	%			16.82	16.72	16.15	
	Nitrogen	%			80.09	79.60	76.89	
	Water	%					4.00	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 102
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9600
F/A = 0.014504
Combustion efficiency = 98.54%
Torque = 5.9 foot pounds
Engine speed = 4105 rpm
Engine exhaust temperature = 1034°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 143 pounds per hour

Carbon monoxide	4.39
Carbon dioxide	449.70
Oxides of nitrogen	0.44
Hydrocarbons, $CH_{y/x}$	1.07
Hydrocarbons, CH_4	1.24
Sulfur dioxide	0.06

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 25 AUGUST 1975
Engine S/N 64100
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	T400-CP-400	CRUISE	File T40001C
B	J = -0.07 L = -0.0006 L' = 0.14 M = -0.00626 M' = 0.28	T = 75°F RH = 47% B = 29.83 in. Hg h = 0.013930 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	108.0	sd	48.3	48.0	46.1	2.64
	Carbon dioxide	%	3.75	sd	3.73	3.71	3.56	3206.59
	Oxides of nitrogen	ppm	53.8	sd	54.6	54.3	52.1	4.90
	Nitric oxide	ppm			52.9	52.5	50.5	4.75
	Nitrogen dioxide	ppm			1.7	1.7	1.6	0.15
	Hydrocarbons, $CH_{y/x}$	ppmC	5.4	w	5.7	5.6	5.4	0.15
	Hydrocarbons, CH_4							0.18
	Oxygen	%			15.93	15.83	15.20	
	Nitrogen	%			80.33	79.85	76.69	
	Water	%					4.53	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 163
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9547
F/A = 0.017389
Combustion efficiency = 99.92%
Torque = 20.1 foot pounds
Engine speed = 5735 rpm
Engine exhaust temperature = 1154°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 283 pounds per hour

Carbon monoxide	0.75
Carbon dioxide	907.46
Oxides of nitrogen	1.39
Hydrocarbons, $CH_{y/x}$	0.04
Hydrocarbons, CH_4	0.05
Sulfur dioxide	0.11

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 25 AUGUST 1975
Engine S/N 64100
Test stand, single point probe at engine exhaust plane.

A	T400-CP-400	MILITARY	File T40001M

B

J = -0.07	T = 75°F	m = 13.0
L = -0.0006	RH = 47%	n = 23.4
L' = 0.14	B = 29.83 in. Hg	η = 0.95
M = -0.00626	h = 0.013930	
M' = 0.28	h_{sd} = 0.00607	

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	79.0	sd	15.7	15.6	15.0	0.75
Carbon dioxide	%	4.31	sd	4.29	4.26	4.08	3206.10
Oxides of nitrogen	ppm	84.2	sd	85.5	85.0	81.2	6.68
Nitric oxide	ppm			82.8	82.3	78.7	6.47
Nitrogen dioxide	ppm			2.7	2.7	2.6	0.21
Hydrocarbons, $CH_{y/x}$	ppmC	4.5	w	4.7	4.7	4.5	0.11
Hydrocarbons, CH_4							0.13
Oxygen	%			15.17	15.08	14.41	
Nitrogen	%			80.53	80.04	76.51	
Water	%					4.99	

D Sulfur dioxide, calc. 0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 223
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9501
F/A = 0.019951
Combustion efficiency = 99.97%
Torque = 36.7 foot pounds
Engine speed = 6310 rpm
Engine exhaust temperature = 1388°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 412 pounds per hour

Carbon monoxide	0.31
Carbon dioxide	1320.91
Oxides of nitrogen	2.75
Hydrocarbons, $CH_{y/x}$	0.05
Hydrocarbons, CH_4	0.05
Sulfur dioxide	0.16

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at MCAS CAMP PENDLETON
Date of measurement 25 AUGUST 1975
Engine S/N 64100
Test stand, single point probe at engine exhaust plane.
JP-5 fuel.

A	GTC85-72	NO LOAD	File GT8501I

B			
	J = −0.07 L = −0.0001 L′ = 0.14 M = −0.00033 M′ = 0.28	T = 68°F RH = 61% B = 29.93 in. Hg h = 0.014080 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	176.1	sd	174.2	173.2	170.4	37.43
Carbon dioxide	%	0.96	sd	0.95	0.95	0.93	3215.88
Oxides of nitrogen	ppm	9.2	sd	9.3	9.2	9.1	3.28
Nitric oxide	ppm			9.0	9.0	8.8	3.18
Nitrogen dioxide	ppm			0.3	0.3	0.3	0.10
Hydrocarbons, $CH_{y/x}$	ppmC	49.4	w	50.5	50.2	49.4	5.36
Hydrocarbons, CH_4							6.22
Oxygen	%			19.68	19.56	19.25	
Nitrogen	%			79.35	78.87	77.59	
Water	%					2.21	

D Sulfur dioxide, calc. 0.40

E
Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 96
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F
K = 0.9779
F/A = 0.004482
Combustion efficiency = 98.60%
Engine speed = 42400 rpm
Engine exhaust temperature = 595°F

G
EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 105 pounds per hour

Carbon monoxide	3.93
Carbon dioxide	337.67
Oxides of nitrogen	0.34
Hydrocarbons, $CH_{y/x}$	0.56
Hydrocarbons, CH_4	0.65
Sulfur dioxide	0.04

H
Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 29 JULY 1976
Engine S/N 126P2245
Test Cell 103, single point probe in test cell exhaust stack.
JP-5 fuel.

A	GTC85-72	LOAD	File GT8501M

B			
	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 68°F RH = 61% B = 29.93 in. Hg h = 0.014080 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C

CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
Carbon monoxide	ppm	157.6	sd	154.4	153.5	149.5	14.83
Carbon dioxide	%	2.14	sd	2.13	2.11	2.06	3208.28
Oxides of nitrogen	ppm	24.3	sd	24.6	24.5	23.8	3.88
Nitric oxide	ppm			23.8	23.7	23.1	3.76
Nitrogen dioxide	ppm			0.8	0.8	0.8	0.12
Hydrocarbons, $CH_{y/x}$	ppmC	2.7	w	2.8	2.8	2.7	0.13
Hydrocarbons, CH_4							0.15
Oxygen	%			18.09	17.98	17.51	
Nitrogen	%			79.76	79.28	77.20	
Water	%					3.21	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 124
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9679
F/A = 0.009974
Combustion efficiency = 99.64%
Engine speed = 42050 rpm
Engine exhaust temperature = 1150°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 210 pounds per hour

Carbon monoxide	3.11
Carbon dioxide	673.74
Oxides of nitrogen	0.81
Hydrocarbons, $CH_{y/x}$	0.03
Hydrocarbons, CH_4	0.03
Sulfur dioxide	0.08

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 29 JULY 1976
Engine S/N 126P2245
Test Cell 103, single point probe in test cell exhaust stack.
JP-5 fuel.

A	GTPC95-2	IDLE	File GT9501I

B			
	J = -0.07 L = -0.0001 L′ = 0.14 M = -0.00033 M′ = 0.28	T = 94°F RH = 18% B = 29.90 in. Hg h = 0.009687 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
	Carbon monoxide	ppm	86.7	sd	84.3	83.8	82.8	18.75
	Carbon dioxide	%	0.94	sd	0.93	0.93	0.92	3259.21
	Oxides of nitrogen	ppm	11.9	sd	12.0	12.0	11.8	4.39
	Nitric oxide	ppm			11.6	11.6	11.4	4.25
	Nitrogen dioxide	ppm			0.4	0.4	0.4	0.14
	Hydrocarbons, $CH_{y/x}$	ppmC	19.3	w	19.6	19.5	19.3	2.16
	Hydrocarbons, CH_4							2.50
	Oxygen	%			19.72	19.60	19.37	
	Nitrogen	%			79.34	78.86	77.94	
	Water	%					1.76	

D	Sulfur dioxide, calc.	0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 135

Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9824

F/A = 0.004331

Combustion efficiency = 99.35%

Engine exhaust temperature = 595°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 131 pounds per hour

Carbon monoxide	2.46
Carbon dioxide	426.96
Oxides of nitrogen	0.58
Hydrocarbons, $CH_{y/x}$	0.28
Hydrocarbons, CH_4	0.33
Sulfur dioxide	0.05

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE

Measurement at NAVAIREWORKFAC ALAMEDA

Date of measurement 15 JUNE 1976

Engine S/N P-28735

Test Cell 115, single point probe in test cell exhaust stack.

JP-5 fuel.

A	GTPC95-2	100%	File GT9501M	

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 94°F RH = 18% B = 29.90 in. Hg h = 0.009687 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	35.5	sd	31.7	31.5	30.8	3.20
	Carbon dioxide	%	2.05	sd	2.04	2.02	1.98	3228.29
	Oxides of nitrogen	ppm	33.7	sd	34.1	33.9	33.2	5.65
	Nitric oxide	ppm			33.0	32.8	32.1	5.47
	Nitrogen dioxide	ppm			1.1	1.1	1.0	0.18
	Hydrocarbons, $CH_{y/x}$	ppmC	7.0	w	7.2	7.2	7.0	0.36
	Hydrocarbons, CH_4							0.42
	Oxygen	%			18.23	18.12	17.73	
	Nitrogen	%			79.73	79.25	77.57	
	Water	%					2.71	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	185
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9729
F/A = 0.009498
Combustion efficiency = 99.89%

Engine exhaust temperature = 1250°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 293 pounds per hour

Carbon monoxide	0.94
Carbon dioxide	945.89
Oxides of nitrogen	1.66
Hydrocarbons, $CH_{y/x}$	0.10
Hydrocarbons, CH_4	0.12
Sulfur dioxide	0.12

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 15 JUNE 1976
Engine S/N P-28735
Test Cell 115, single point probe in test cell exhaust stack.
JP-5 fuel.

A	GTCP100-54	IDLE	File GT1001I

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 77°F RH = 36% B = 29.82 in. Hg h = 0.011338 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	56.0	sd	53.4	53.1	52.4	12.48
	Carbon dioxide	%	0.90	sd	0.89	0.89	0.88	3276.38
	Oxides of nitrogen	ppm	16.3	sd	16.5	16.4	16.2	6.32
	Nitric oxide	ppm			16.0	15.9	15.7	6.12
	Nitrogen dioxide	ppm			0.5	0.5	0.5	0.20
	Hydrocarbons, $CH_{y/x}$	ppmC	13.7	w	14.0	13.9	13.7	1.61
	Hydrocarbons, CH_4							1.87
	Oxygen	%			19.77	19.66	19.40	
	Nitrogen	%			79.33	78.85	77.83	
	Water	%					1.88	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 188
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9812
F/A = 0.004125
Combustion efficiency = 99.55%
Engine speed = 35730 rpm
Engine exhaust temperature = 560°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 225 pounds per hour

Carbon monoxide	2.81
Carbon dioxide	737.19
Oxides of nitrogen	1.42
Hydrocarbons, $CH_{y/x}$	0.36
Hydrocarbons, CH_4	0.42
Sulfur dioxide	0.09

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 28 JUNE 1976
Engine S/N P9907
Test Cell 114, single point probe in test cell exhaust stack.
JP-5 fuel.

A	GTCP100-54	100%	File GT1001M
B	J = -0.07 L = -0.0001 L′ = 0.14 M = -0.00033 M′ = 0.28	T = 77°F RH = 36% B = 29.82 in. Hg h = 0.011338 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	Calculated semi-dry	Calculated wet	EMISSION INDEX
C	Carbon monoxide	ppm	52.3	sd	48.9	48.6	47.6	5.89
	Carbon dioxide	%	1.72	sd	1.71	1.70	1.66	3234.53
	Oxides of nitrogen	ppm	29.7	sd	30.0	29.9	29.3	5.95
	Nitric oxide	ppm			29.1	28.9	28.3	5.76
	Nitrogen dioxide	ppm			0.9	0.9	0.9	0.19
	Hydrocarbons, $CH_{y/x}$	ppmC	2.7	w	2.8	2.8	2.7	0.16
	Hydrocarbons, CH_4							0.19
	Oxygen	%			18.67	18.56	18.19	
	Nitrogen	%			79.61	79.13	77.56	
	Water	%					2.59	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 190
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9741
F/A = 0.007963
Combustion efficiency = 99.85%
Engine speed = 35190 rpm
Engine exhaust temperature = 975°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 413 pounds per hour

Carbon monoxide	2.43
Carbon dioxide	1335.86
Oxides of nitrogen	2.46
Hydrocarbons, $CH_{y/x}$	0.07
Hydrocarbons, CH_4	0.08
Sulfur dioxide	0.17

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAIREWORKFAC ALAMEDA
Date of measurement 28 JUNE 1976
Engine S/N P9907
Test Cell 114, single point probe in test cell exhaust stack.
JP-5 fuel.

A	**T-62T-27**	**IDLE**	**File T62011**

B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 83°F RH = 30% B = 29.80 in. Hg h = 0.011442 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

C	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
	Carbon monoxide	ppm	149.0	sd	146.9	146.0	143.9	29.53
	Carbon dioxide	%	1.03	sd	1.02	1.02	1.00	3228.98
	Oxides of nitrogen	ppm	15.9	sd	16.1	16.0	15.7	5.31
	Nitric oxide	ppm			15.6	15.5	15.3	5.14
	Nitrogen dioxide	ppm			0.5	0.5	0.5	0.17
	Hydrocarbons, $CH_{y/x}$	ppmC	29.2	w	29.8	29.6	29.2	2.96
	Hydrocarbons, CH_4							3.43
	Oxygen	%			19.59	19.47	19.20	
	Nitrogen	%			79.37	78.89	77.77	
	Water	%					2.01	

D	Sulfur dioxide, calc.	0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	161
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F	K = 0.9799 F/A = 0.004788 Combustion efficiency = 99.02% Engine speed = 4330 rpm Engine exhaust temperature = 640°F

G	EMISSION RATE (pounds of constituent per hour) for a fuel flow rate of 50 pounds per hour	
	Carbon monoxide	1.48
	Carbon dioxide	161.45
	Oxides of nitrogen	0.27
	Hydrocarbons, $CH_{y/x}$	0.15
	Hydrocarbons, CH_4	0.17
	Sulfur dioxide	0.02

H	Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE Measurement at NAVAIREWORKFAC ALAMEDA Date of measurement 28 JUNE 1976 Engine S/N S-424421 Test Cell 116, single point probe in test cell exhaust stack. JP-5 fuel.

A	T-62T-27	100%	File T6201M
B	J = -0.07 L = -0.0001 L' = 0.14 M = -0.00033 M' = 0.28	T = 83°F RH = 30% B = 29.80 in. Hg h = 0.011442 h_{sd} = 0.00607	m = 13.0 n = 23.4 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	344.2	sd	342.7	340.6	334.0	42.77
	Carbon dioxide	%	1.62	sd	1.61	1.60	1.57	3154.46
	Oxides of nitrogen	ppm	19.0	sd	19.2	19.1	18.7	3.94
	Nitric oxide	ppm			18.6	18.5	18.1	3.82
	Nitrogen dioxide	ppm			0.6	0.6	0.6	0.12
	Hydrocarbons, $CH_{y/x}$	ppmC	123.2	w	126.4	125.6	123.2	7.79
	Hydrocarbons, CH_4							9.04
	Oxygen	%			18.78	18.66	18.30	
	Nitrogen	%			79.58	79.10	77.56	
	Water	%					2.54	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet) Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	127
F	K = 0.9746 F/A = 0.007693 Combustion efficiency = 98.23% Shaft horsepower = 100 Engine speed = 4240 rpm Engine exhaust temperature = 970°F	
G	EMISSION RATE (pounds of constituent per hour) for a fuel flow rate of 102 pounds per hour Carbon monoxide 4.36 Carbon dioxide 321.76 Oxides of nitrogen 0.40 Hydrocarbons, $CH_{y/x}$ 0.79 Hydrocarbons, CH_4 0.92 Sulfur dioxide 0.04	
H	Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE Measurement at NAVAIREWORKFAC ALAMEDA Date of measurement 28 JUNE 1976 Engine S/N S-424421 Test Cell 116, single point probe in test cell exhaust stack. JP-5 fuel.	

A	WR27-1	LOW FLOW 38 CAM	File WR2701B
B	J = -0.07 L = -0.0008 L' = 0.14 M = -0.00658 M' = 0.28	h = 0.010000 h_{sd} = 0.00607	m = 9.5 n = 19.0 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	76.6	sd	25.3	25.1	24.7	3.48
	Carbon dioxide	%	1.49	sd	1.48	1.47	1.44	3199.86
	Oxides of nitrogen	ppm	9.3	sd	9.4	9.3	9.2	2.13
	Nitric oxide	ppm			9.1	9.1	8.9	2.06
	Nitrogen dioxide	ppm			0.3	0.3	0.3	0.07
	Hydrocarbons, $CH_{y/x}$	ppmC	8.5	w	8.7	8.7	8.5	0.60
	Hydrocarbons, CH_4							0.69
	Oxygen	%			18.93	18.81	18.47	
	Nitrogen	%			79.59	79.11	77.68	
	Water	%					2.40	
D	Sulfur dioxide, calc.							0.40

E	Oxides of nitrogen at 3% oxygen, calc.(ppm wet)	67
	Oxides of nitrogen at 3% oxygen, meas.(ppm wet)	

F

K = 0.9760
F/A = 0.006974
Combustion efficiency = 99.86%
Shaft horsepower = 85
Engine speed = 102.7 percent rpm
Engine exhaust temperature = 1160°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 140 pounds per hour

Carbon monoxide	0.49
Carbon dioxide	447.98
Oxides of nitrogen	0.30
Hydrocarbons, $CH_{y/x}$	0.08
Hydrocarbons, CH_4	0.10
Sulfur dioxide	0.06

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAL AIR STATION, NORTH ISLAND
Date of measurement 10 DECEMBER 1975
Engine S/N 121
APU Test Stand, probe at engine exhaust plane.

A	WR27-1	HIGH FLOW 90 CAM	File WR2701C	

B	J = -0.07 L = -0.0007 L' = 0.14 M = -0.00658 M' = 0.28	h = 0.010000 h_{sd} = 0.00607	m = 9.5 n = 19.0 η = 0.95

	CONSTITUENT		EXHAUST CONCENTRATION Measured		Calculated dry	semi-dry	wet	EMISSION INDEX
C	Carbon monoxide	ppm	121.7	sd	66.0	65.6	63.9	5.66
	Carbon dioxide	%	2.37	sd	2.36	2.34	2.28	3171.54
	Oxides of nitrogen	ppm	32.5	sd	32.9	32.7	31.8	4.63
	Nitric oxide	ppm			31.9	31.7	30.8	4.49
	Nitrogen dioxide	ppm			1.0	1.0	1.0	0.15
	Hydrocarbons, $CH_{y/x}$	ppmC	4.8	w	5.0	4.9	4.8	0.21
	Hydrocarbons, CH_4							0.24
	Oxygen	%			17.70	17.59	17.13	
	Nitrogen	%			79.94	79.45	77.35	
	Water	%					3.23	
D	Sulfur dioxide, calc.							0.40

E

Oxides of nitrogen at 3% oxygen, calc.(ppm wet) 150
Oxides of nitrogen at 3% oxygen, meas.(ppm wet)

F

K = 0.9677
F/A = 0.011153
Combustion efficiency = 99.85%
Shaft horsepower = 85
Engine speed = 101.9 percent rpm
Engine exhaust temperature = 1260°F

G

EMISSION RATE (pounds of constituent per hour)
for a fuel flow rate of 140 pounds per hour

Carbon monoxide	0.79
Carbon dioxide	444.02
Oxides of nitrogen	0.65
Hydrocarbons, $CH_{y/x}$	0.03
Hydrocarbons, CH_4	0.03
Sulfur dioxide	0.06

H

Measurement by AIRCRAFT ENVIRONMENTAL SUPPORT OFFICE
Measurement at NAVAL AIR STATION, NORTH ISLAND
Date of measurement 10 DECEMBER 1975
Engine S/N 121
APU Test Stand, probe at engine exhaust plane.